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Il est constitué en outre du président de la Société suisse de Zoologie, du directeur du Muséum de Genève et de représentants des instituts de zoologie des universités suisses.

Les manuscrits sont soumis à des experts d'institutions suisses ou étrangères selon le sujet étudié.

La préférence sera donnée aux travaux concernant les domaines suivants: biogéographie, systématique, évolution, écologie, éthologie, morphologie et anatomie comparée, physiologie.

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New records of phoretic and soil-living mites from Iran (Acari, Heterostigmata, Scutacaridae)

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New records of phoretic and soil-living mites from Iran (Acari, Heterostigmata, Scutacaridae). - *Scutacarus iranicus* sp. n. is described from the West-Azarbaijan province (northwestern Iran). The new species was found to be phoretic on the scarabaeid beetle *Pleurophorus anatolicus* Petr. At the same locality, but in the soil, other scutacarids were found: *Scutacarus quadrangularis* (Paoli, 1911), *Scutacarus serotinus* Sevastianov & Chydyrov, 1992, *Pygmodispus (Allodispus) latisternus* Paoli, 1911 and *Pygmodispus (Pygmodispus) calcaratus* Paoli, 1911. These species are recorded for the first time from Iran.

Key-words: Acari - Scutacaridae - new species - phoresy - scarabaeid beetle - Iran.

INTRODUCTION

The scutacarid fauna of Iran is almost unknown. In 1970 Mahunka & Rohde described the new species *Heterodispus verrucosus* and this was the first record of a representative of the mite family Scutacaridae from Iran. Since this record, only a few additional species have been reported (Kamali *et al.,* 2001): These are *Imparipes parapicolosimilis* Metwaly, 1971, *Scutacarus longitarsus* (Berlese, 1905), *Scutacarus fragariae* Rack, 1975 and *Scutacarus contiguus* Delfinado, Baker & Abbatiello, 1976. Pedobiological collections from sugarbeet-fields in northwestern Iran (by the second author, H. H.) yielded some scutacarid species which are presented here.

MATERIAL AND METHODS

Locality: Miandoab plain, West-Azarbaijan province (northwestern Iran), sugarbeet fields. Dates of collecting: sample-number 1: April 19, no.2: May 4, no.4: May 15 and May 16, no.5: May 15, no.6: September 14. All soil samples were collected by H. H. in 2000. Mites and beetles were extracted by using Berlese-Tullgren-funnels.

The mites were determinated by the first author (E. E.), the beetles by F.-T. Krell. The material was collected in course of investigations for the master thesis of the second author (H. H.) under the supervision of the third author (K. H.)

The following abbreviations are used in the description: ap. = apodeme, Fe = femur, Ge = genu, lTa = length of tarsus, lPrTa = length of pretarsus, PrTa = pretarsus, pstpl = posteriore sternal plate, sol = solenidion, Ta = tarsus, Ti = tibia, TiTa = tibiotarsus, Tr = trochanter, x= average, = =about the same length, < = shorter than, > = longer than.

RESULTS

DESCRIPTION OF THE NEW SPECIES

Scutacarus iranicus sp. n. (female)   Figs 1-3

Material and deposition: 8 ♀♀ from sample 6. Holotype specimen and four paratypes in the Muséum d'histoire naturelle Genève (Switzerland), two paratypes in the Zoologisches Institut und Zoologisches Museum, University of Hamburg (Germany), one paratype in the Acarological Collection, Zoological Museum, College of Agriculture, Tehran University, Karaj (Iran).

Diagnosis: *Scutacarus iranicus* sp. n. is characterized by the comparatively rare feature "setae e and h1 tiny". It shares this feature with little more than 20 species, which have tiny or completely reduced setae e. *Scutacarus iranicus* sp. n. is most closely related to the „*tackei*-species group". Members of this group are *Scutacarus tackei* Willmann, 1942, *S. ellipticus* Karafiat, 1959, *S. suborbiculatus* Rack, 1964 and *S. terrenus* Delfinado & Baker, 1976.

The most important differences between *S. iranicus* sp. n. and *S. tackei* are: *iranicus*: alveolar canals of setae c1 and c2 long, *tackei*: only in c2 long; *iranicus*: h1 somewhat longer than f, *tackei*: h1 two times longer than f; *iranicus*: 3b arising far in front of 3a and 3c, *tackei*: 3a, 3b and 3c nearly in one line; *iranicus*: ps1 and ps2 < 4a, with only a few barbs, *tackei*: ps1 = 4a or ps1 > 4a, ps1 and ps2 densely barbed; *iranicus*: tip of claw of legI rather blunt, *tackei*: claw with thin, elongated tip; *iranicus*: sol ω1 > φ1, *tackei*: ω1 = φ1; *iranicus*: tc"IV thick with strong spines, *tackei*: tc"IV thin with fine barbs.

The most important differences between *S. iranicus* and *S. ellipticus* are: *iranicus*: c1, c2 and d distally smooth or sparsely barbed, *ellipticus*: c1, c2 and d distally densely barbed; *iranicus*: f slightly thinner than d, *ellipticus*: f distinctly thinner than d; *iranicus*: 4b and 4c being the thickest of all ventral setae, *ellipticus*: 4b and 4c very thin; *iranicus*: ps1 > ps2, with only a few barbs, ps1 and ps2 < 4a, *ellipticus*: ps1 = ps2, both setae densely barbed, ps1 and ps2 > 4a; *iranicus*: e and h2 tiny, *ellipticus*: e and h2 completely reduced; *iranicus*: claw of leg I large, tip of the claw rather blunt, *ellipticus*: claw small with very thin, elongated tip.

The most important differences between *S. iranicus* and *S. suborbiculatus* are: *iranicus*: d > f, *suborbiculatus*: f > d; *iranicus*: 3b arising far in front of 3a and 3c, 3a, 3b, 3c shorter than in *suborbiculatus*, 3c not reaching insertion of 4b, *suborbiculatus*: 3a, 3b and 3c standing in one line, these setae longer than in *iranicus*, 3c extending beyond insertions of 4b; *iranicus*: e and h2 tiny, *suborbiculatus*: e and h2 completely
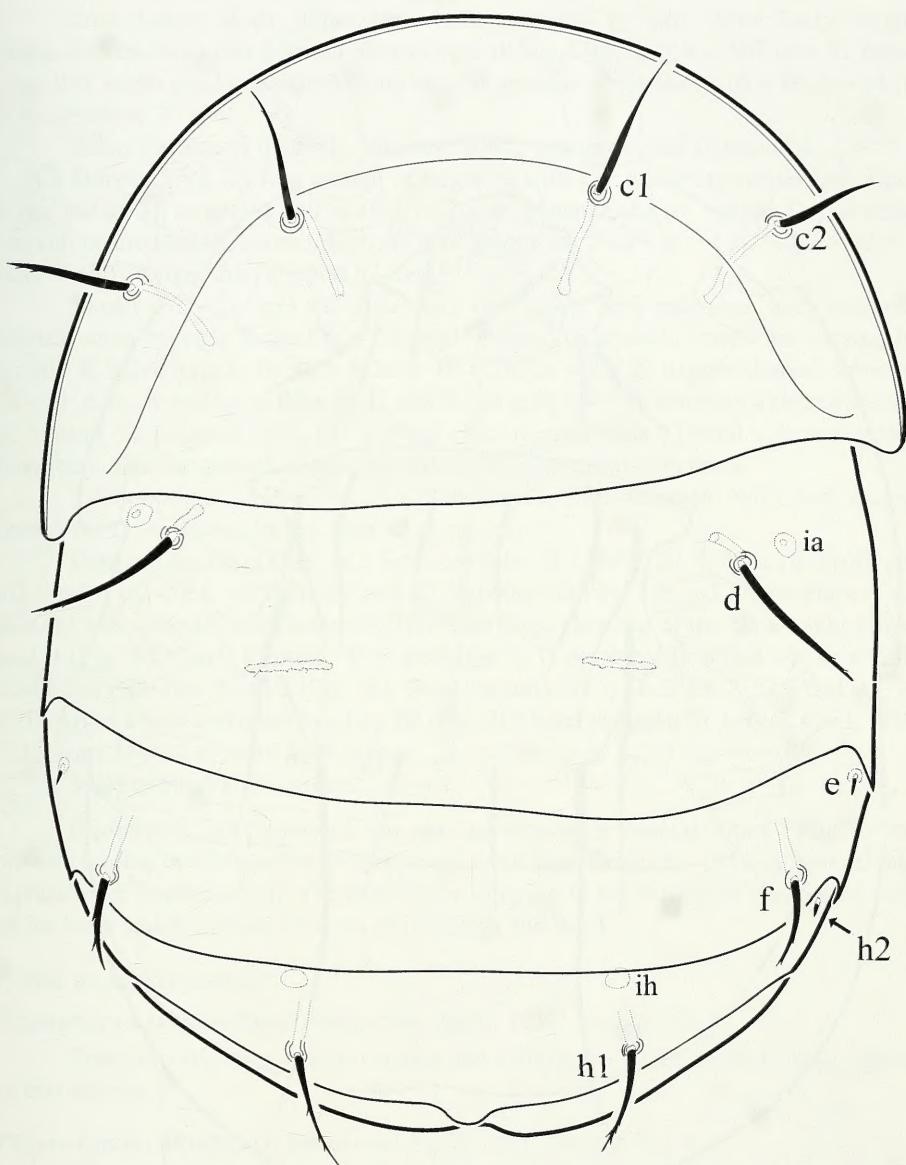
FIG. 1

*Scutacarus iranicus* sp. n. (female holotype) – dorsal view; body length 190 μm.

reduced; *iranicus*: tip of claw of leg I rather blunt, *suborbiculatus*: claw with very thin, elongated tip.

The most important differences between *S. iranicus* and *S. terrenus* are: *iranicus*: TiTa I with 4 solenidia, *terrenus*: TiTa I with 3 solenidia only.

Fig. 2

Scutacarus iranicus sp. n. (female holotype) – ventral view.

Description: Body dimensions (measurements in μm): Total body length (measured on about one year old microscopic slides) 146 – 190, x = 167 (n = 8), holotype 190; width pstpl (measured along anterior margin of the plate): 65 – 80, x = 74 (n = 8), holotype 79.

Entire surface of the body with tiny pores; cupulae ia and ih roundish.

Dorsum (Fig. 1): free margin of tergite C with fine, radiating stripes (not illustrated in Fig. 1); alveolar canal of all dorsal setae, except e and h1, visible. Dorsal setae smooth or moderately barbed, their relative length: c1 > c2 < d > e < f < h1 > h2, h1 only slightly longer than f, e and h2 tiny.

Venter (Fig. 2): ap.1, 2, 3 strongly developed, ap.4 extended, ap.5 reduced. Ventral setae strongly barbed or moderately barbed or smooth, somewhat varying in length. Relative length: 1a > 1b > 2a or 1b = 2a, 2a = 2b. 2b dagger-shaped, smooth. 3a < 3b < 3c, 3b arising in front of 3a and 3c; 4a < 4b > 4c, 4b standing a short distance in front of 4a; ps1>ps2 >ps3, ps1 and ps2 close to each other. Genital sclerite broader than long, anterior genital sclerite laterally with sclerotized structures.

Trichobothrium sc1 (Fig. 3b): club-shaped, thin-stemmed, with fine scales, outer seta v1 somewhat longer than v2 or reverse.

Extremities: Leg I (Fig. 3c): Setal formula: Tr 1, Fe 2, Ge 4, TiTa 16 (4sol), sol ω2 < ω1 > φ2 < φ1, ω2 thin, ω1 and φ2 standing side by side, ω1 finger-shaped, φ2 thin, φ1 club-shaped, thin-stemmed; TiTa with large claw, tip of the claw rather blunt. Leg II (Fig. 3d): Setal formula: Tr 1, Fe 3, Ge 3, Ti 4(sol φ), Ta 6 (sol ω); Ta with 2 claws and pulvillus. Leg III (Fig. 3e): Setal formula: Tr 1, Fe 2, Ge 2, Ti 4 (sol φ), Ta 6; Ta with 2 claws and pulvillus. Leg IV (Fig. 3f): Setal formula: Tr 1, Fe 2, Ge 1, TiTa 7; tc' > pv" > tc", tc" with thick spines.

Male and larva: Unknown.

Bionomics: Specimens of the new species were several times found to be phoretic on the beetle species *Pleurophorus anatolicus* Petrovitz, 1961 (Scarabaeidae: Aphodiinae: Psammodiini). The mites were clinging to the sutures of the ventral side of the head and the suture between the forelegs and head.

OTHER IDENTIFIED SPECIES

Pygmodispus (Pygmodispus) calcaratus Paoli, 1911: Sample No. 5.

Some records from North America and Eurasia verify the holarctic distribution of this species.

Pygmodispus (Allodispus) latisternus Paoli, 1911: Sample No. 4.

This species is recorded from Western and Central Europe, as well as from Mongolia and North Africa.

Scutacarus quadrangularis (Paoli, 1911): Sample No. 1.

This is one of the most common scutacarid species, it is widely distributed in Eurasia and also recorded from Australia and New Zealand.

Scutacarus serotinus Sevastianov & Chydyrov, 1992: Sample No.2.

Hitherto this species was only known from Turkmenistan.
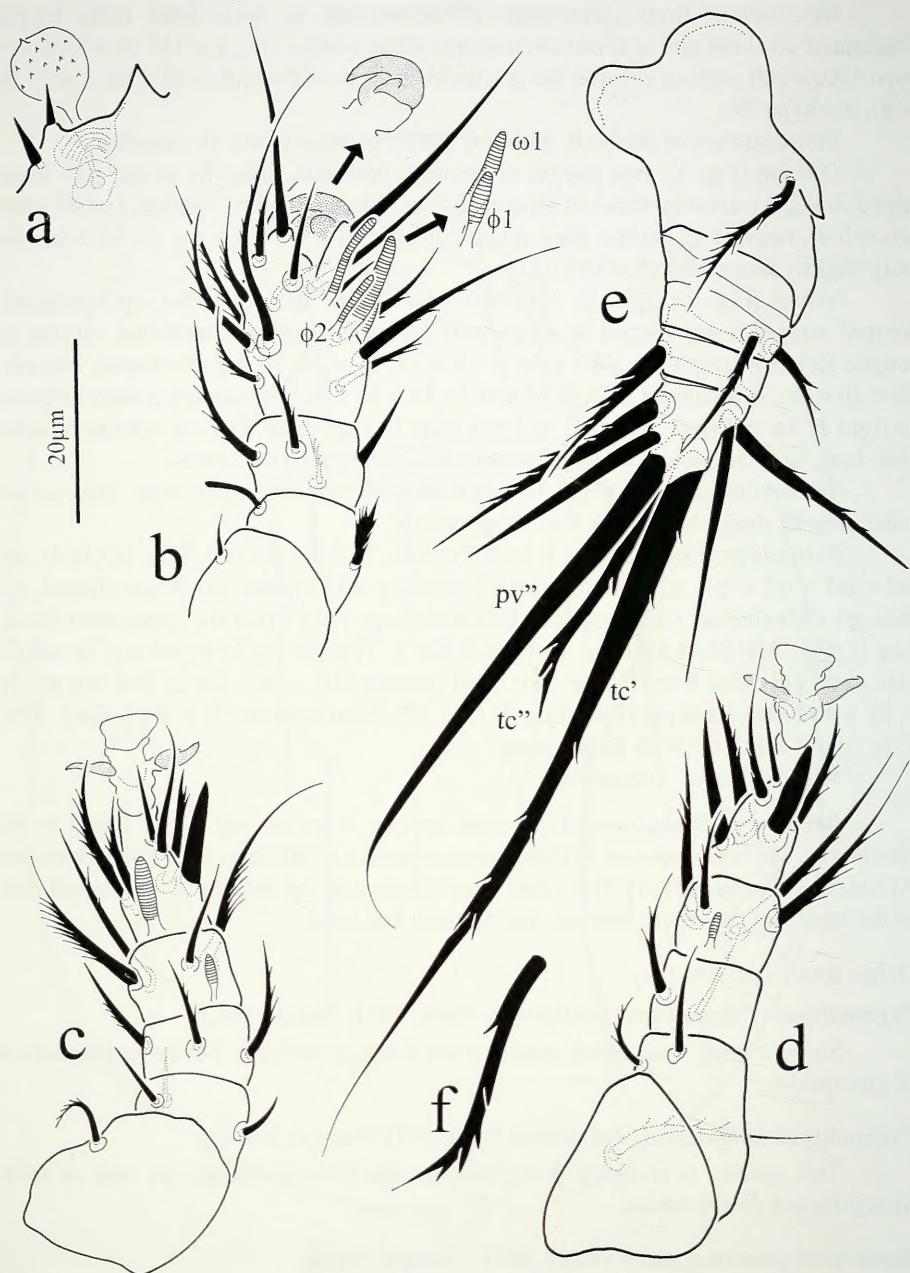
FIG. 3

Scutacarus iranicus sp. n. (female holotype) – a = trichobothrium, b = leg I (arrows: dorsal view of claw, solenidia ω1 and φ1), c = leg II, d = leg III, e = leg IV, f = seta tc" from opposite leg IV.

DISCUSSION

The finding of S. *iranicus* sp. n. on *Pleurophorus anatolicus* is especially remarkable as there is hardly anything known about associations between Scarabaeids and Scutacarids. Beetles of the family Scarabaeidae have only once been reported as phoretic hosts for Scutacarids: Norton (1973) discovered some phoretic ♀ ♀ of *Heterodispus* sp. on the North American Hermit Flower Beetle (*Osmoderma eremicola* Knoch). Amongst Coleoptera the family Carabidae is the most thoroughly investigated one. Beetles of this family are known to be used very frequently as phoretic hosts by a high number of scutacarid species, especially those of the genus *Archidispus* (e.g., Kurosa, 1991). Furthermore, some other beetles' families are known to be phoretic hosts (Ebermann, 1988).

With the five species recorded in this paper the number of scutacarid species recorded from Iran has been increased to ten. This number most probably still underestimates the actual number, considering the high number of species already known to occur in Eurasia. The remarkable geographical diversity of Iran and its rich ecological differentiation will deserve more targeted investigations in the future. Soil samples and insects, mainly beetles, ants and other Hymenoptera, can be expected to yield a high number of already described, and also of new species of phoretic and nonphoretic scutacarids.

ACKNOWLEDGEMENT

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Homalotini del Borneo
(Coleoptera, Staphylinidae)*

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Homalotini from Borneo (Coleoptera, Staphylinidae). - The species of the genera *Stenomastax* Cameron, 1933, *Coenonica* Kraatz, 1857, *Mimopisalia* Pace, 1984, *Neosilusa* Cameron, 1920, *Neocoenonica* Cameron, 1950, *Neomalota* Cameron, 1920 and *Linoglossa* Kraatz, 1859 are studied for the fauna of Borneo. *Stenomastax* includes now 21 species (18 species new), *Coenonica* 31 species (21 species new), *Mimopisalia* 6 species (4 species new), *Neosilusa* 4 species (one new) and *Linoglossa* is recorded for the first time from Borneo with one new species. Based on the study of the types of the species of the five genera already described from Borneo the following new synonyms are proposed: *Deralia* Cameron is a junior synonym of *Coenonica* Kraatz and *C. soror* Cameron, 1933 a junior synonym of *C. nigrita* Cameron, 1933. New data are given for some already described species. All new species are described, illustrated and compared with similar looking species. Keys to all species of Borneo of the 5 genera mentioned above are presented.

Key-words: Coleoptera - Staphylinidae - Aleocharinae - taxonomy - Borneo.

INTRODUZIONE

I generi della tribù Homalotini Heer, 1839, quali *Stenomastax* Cameron, 1933, *Coenonica* Kraatz, 1857, *Mimopisalia* Pace, 1984, *Neosilusa* Cameron, 1920 e *Neocoenonica* Cameron, 1950 erano finora noti del Borneo. I generi *Neomalota* Cameron, 1920 e *Linoglossa* Kraatz, 1859, sono nuovi per questa grande isola. Il genere *Stenomastax* era rappresentato da tre specie: *S. nigrescens* (Fauvel, 1905), *S. tuberculicollis* (Kraatz, 1859) e *S. borneensis* Cameron, 1933. Nel presente lavoro questo genere si arricchisce di diciotto nuove specie. Il genere *Coenonica* nel Borneo era rappresentato da dieci specie: *C. vulnerata* Bernhauer, 1915, *C. abdominalis* Cameron, 1930, *C. soror* Cameron, 1933, *C. nigrita* Cameron, 1933, *C. monticola* Cameron, 1933, *C. borneensis* Cameron, 1933, *C. rufiventris* Cameron, 1943, *C. sarawakensis* Cameron, 1943, *C. puncticollis* Kraatz, 1857 e *C, ashei* Pace, 1987. Nel presente lavoro questo genere si arricchisce di ventuno nuove specie. Il genere *Mimopisalia* era rappresentato da due sole specie: *M. borneensis* (Cameron, 1933) e *M. kinabaluensis*

Pace, 1989. Nel presente lavoro ne sono aggiunte quattro, tutte nuove. All'unica specie del genere *Neosilusa*, *N. borneensis* (Cameron, 1928), se ne aggiunge un'altra. *N. stricticollis* Cameron, 1943, non appartiene a questo genere (Pace, 2002). Per il genere *Neocoenonica* si conferma la presenza di *N. antennalis* (Cameron, 1936), citata da Hammond (1984), come *Drusilla antennalis* (Cameron, 1936) ("olim" *Astilbus*).

Le prime Aleocharinae del Borneo sono state raccolte da J.C. Moulton nel 1912. Successivamente furono G.E. Bryant nel 1913-1914 ed E. Mjöberg a contribuire a raccogliere nuovo materiale. Le raccolte di H.M. Pendlebury nel 1927 e nel 1929 sono state studiate da Cameron (1930 e 1933). D.H. Kistner e J.M. Pasteel dal 1969 al 1976 descrivono varie specie di Aleocharinae termitofile. Altre raccolte sono state effettuate da M.E. Bacchus nel 1976 e nel 1977-1978 da P.M Hammond, del Museo di Storia Naturale di Londra, e altri membri della Società Geografica Reale, nel corso della spedizione al Monte Mulu nel Sarawak (*Royal Geographic Society Gunung Mulu Expedition*). Nel 1990 il collega Guillaume de Rougemont raccolse sul Monte Kinabalu (Borneo) alcune Aleocharinae da me esaminate.

Il presente lavoro si basa sulle importantissime e abbondanti raccolte effettuate nelle spedizioni sul Monte Kinabalu e dintorni dal Dr. Ales Smetana di Ottawa, dal Dr. Ivan Löbl e dal Dr. Daniel Burckhardt, entrambi già del museo di Storia Naturale di Ginevra. Sono integrate da alcuni esemplari raccolti dal Prof. Herbert Franz di Mödling (Austria), da una piccola collezione posseduta dal Dr. Volker Assing di Hannover e un esemplare donatomi dall'Ing. Jiri Janák di Rtyne nad Bìlinou (Repubblica Ceca).

Gli olotipi delle nuove specie sono conservati nel Museo di Storia Naturale di Ginevra (MHNG), nel Museo Regionale di Scienze Naturali di Torino (MRSN) e in collezione Franz al Naturhistorisches Museum di Vienna (NHMW).

SERIE TIPICHE ESAMINATE, RIGUARDANTI SPECIE DEL BORNEO

Stenomastax variventris (Kraatz, 1859)
Homalota variventris Kraatz, 1859: 34
2 ♂♂ e 2 ♀♀, Ceylon, J. Nietner, sintipi (coll. Kraatz, DEI).

Stenomastax tuberculicollis (Kraatz, 1859)
Homalota tuberculicollis Kraatz, 1859: 33
1 ♂ e 3 ♀♀, Ceylon, J. Nietner, sintipi (coll. Kraatz, DEI).

Stenomastax nigrescens (Fauvel, 1905)
Homalota nigrescens Fauvel, 1905: 147
1 ♀, Sumatra, Paja Kombo; 1 ♂ e 1 ♀, Sukaburmi, sintipi (coll. Fauvel, Bruxelles).

Coenonica soror Cameron, 1933
Coenonica soror Cameron, 1933: 354
Holotypus ♀, B.N. Borneo, Mt. Kinabalu, Kamborangah, 7200 ft., 23.3.1929, *C. soror* Cam. TYPE (coll. Cameron, Londra)

Coenonica nigrita Cameron, 1933
Coenonica nigrita Cameron, 1933: 354
Holotypus ♀, B.N. Borneo, Mt. Kinabalu, Kamborangah, 7500 ft., 23.3.1929, *C. nigrita* Cam. TYPE (coll. Cameron, Londra).

Nota. La spermateca degli olotipi di *Coenonica soror* Cameron, 1933 e di *Coenonica nigrita* Cameron, 1933 ha forma identica nelle due specie, figg. 178 e 179. Cameron ha descritto due specie differenti probabilmente in base al colore differente del corpo: capo rossiccio in *soror*, capo nero in *nigrita*. Tranne queste differenze non se ne osservano altre. Identico è il sistema di reticolazione, uguale il rapporto larghezza/lunghezza del pronoto e delle elitre. Inoltre le due specie sono state raccolte nello stesso giorno e nella stessa località. Solo la quota altimetrica è di poco differente e *nigrita* è stata raccolta a quota superiore. Non è una novità che esemplari di una medesima specie di Aleocharinae presentino fenomeni di melanismo per le quote altimetriche superiori. In base a questi dati e soprattutto per la forma identica della spermateca è proposta la seguente sinonimia: **Coenonica soror** Cameron, 1933, *Coenonica soror* Cameron, 1933: 354, *Coenonica nigrita* Cameron, 1933: 354, **syn. n.** La descrizione di *Coenonica soror* precede quella di *Coenonica nigrita* nella stessa pagina.

Coenonica monticola Cameron, 1933

Coenonica monticola Cameron, 1933: 355
        Holotypus ♀, B.N. Borneo, Mt. Kinabalu, Pakka, 10,700 ft., 21.Mar.1929, *Coenonica monticola* Cam, TYPE (coll. Cameron, Londra).

Coenonica borneensis Cameron, 1933

Coenonica borneensis Cameron, 1933: 353
        Holotypus ♀, B.N. Borneo, Mt. Kinabalu, Lumu Lumu, 5500 ft., 16.4.1929, *Coenonica borneensis* Cam. TYPE, M. Cameron Bequest BM 1955-147 (coll. Cameron, Londra).

Coenonica rufiventris Cameron, 1943

Coenonica rufiventris Cameron, 1943: 41
        Holotypus ♀, Borneo, Mt. Pais, *C. rufiventris* Ca., TYPE (coll. Cameron, Londra).

Coenonica sarawakensis Cameron, 1943

Coenonica sarawakensis Cameron, 1943: 40
        Holotypus ♀, Mt. Matang, XII.1913, *C. sarawakensis* Cam. TYPE (coll. Cameron, Londra).

Coenonica vulnerata Bernhauer, 1915

Coenonica vulnerata Bernhauer, 1915: 148
        Holotypus ♂, Mt. Matang, 1000 ft., Sarawak, 3.XII.1913, Moulton (coll. Bernhauer, Chicago). Esaminato da Sawada (1980) che ne ha pubblicato e illustrato edeago e caratteri distintivi.

Coenonica ashei Pace, 1987

Coenonica ashei Pace, 1987: 39
        Holotypus ♂, Borneo, Baker, 13449, *Coenonica philippina* Brnh, det. Bernhauer, Holotypus *Coenonica ashei* Pace (coll. Bernhauer, Chicago).

Mimopisalia borneensis (Cameron, 1933)

Leptusa borneensis Cameron, 1933: 355
Mimopisalia borneensis: Pace, 1984b: 901
        Holotypus ♂, B.N. Mt. Kinabalu, Pakka, 10-200 ft., 21.Mar.1929, *Leptusa borneensis* Cam. TYPE (coll. Cameron, Londra).

Mimopisalia kinabaluensis Pace, 1989

Mimopisalia kinabaluensis Pace, 1989: 6
        Holotypus ♂, Sabah, Mt. Kinabalu, 2600 m, 2.V.1987, leg. Burckhardt & Löbl, (MHNG).

Apatelieida stricticollis (Cameron, 1943)

Neosilusa stricticollis Cameron, 1943: 40
Neosilusa stricticollis: Hammond, 1984: 211
Apatelieida stricticollis: Pace, 2002: 232
    Holotypus ♀, Borneo, Mt. Poi, 5000 ft., *N. stricticollis* Cam., TYPE (coll. Cameron, Londra).

Neocoenonica antennalis (Cameron, 1936)

Astilbus antennalis Cameron, 1936: 18
Drusilla antennalis Hammond, 1984: 209
Neocoenonica antennalis: Cameron, 1950: 94
    Holotypus ♂, The Gap, Selangor, Dr. Cameron, *Astilbus antennalis* Cam., TYPE, *Astilbus antennalis* removed to Bolitocharini, tarsi 4,4,5, gen. nov.; 4 es. stessa provenienza; 1 ♂, Sumatra, Fort de Koch, leg. Jacobson (coll. Cameron, Londra).

Neosilusa ceylonica (Kraatz, 1857)

Stenusa ceylonica Kraatz, 1857: 8
Neosilusa ceylonica:Cameron, 1920: 233
Plagiusa ceylonica: Cameron,1939: 167
Neosilusa ceylonica: Blackwelder, 1952: 260
    7 ♀♀, Ceylon, J. Nietner, *Stenusa ceylonica* Kraatz, SYNTYPI (coll. Kraatz, DEI).

Neosilusa tropica (Bernhauer, 1915)

Silusa (Plagiusa) tropica Bernhauer, 1915: 28
Neosilusa tropica: Pace, 1984a: 17
    Holotypus ♀, Sumatra, Madan Veth, *Bolitochara amabilis* Motsch., *Silusa (Plagiusa) tropica* Brnh., TYPUS UNIC.(coll. Bernhauer, Chicago).

Neomalota cingulata Cameron, 1920

Neomalota cingulata Cameron, 1920: 245
    Holotypus ♂, Singapore, Bukit Timah, *Neomalota cingulata* Cam. TYPE (coll. Cameron, Londra).

    Da questo elenco, purtroppo, mancano tre specie di Homalotini del Borneo quali *Stenomastax borneensis* Cameron, 1933, *Coenonica abdominalis* Cameron, 1930 e *Neosilusa borneensis* Cameron, 1928, non ottenute in esame dal Museo di Storia Naturale di Londra (Dr. M. Brendell), nonostante mia richiesta. La giustificazione è stata la restrizione in corso (1999) per il prestito di materiale tipico. Pertanto tutti i riferimenti a queste specie, nel presente lavoro sono basati sulla descrizione originale di Cameron.

ELENCO DELLE SPECIE NOTE

Stenomastax variventris (Kraatz, 1859)

Homalota variventris Kraatz, 1859: 34
Stenomastax variventris Cameron, 1939: 177
    1 ♀, Sabah, Poring Hot Springs, 500 m, 7.V.1987, leg. Burckhardt & Löbl;10 es., Sabah, Mt. Kinabalu, Poring Hot Springs, 480-520 m, 8-9-10.V.1987, leg. A. Smetana; 2 es., Sabah, Mt. Kinabalu, Poring Hot Springs, 510 m, 30.VIII.1988, leg. A. Smetana; 13 es., Sabah, Mt. Kinabalu N.P., Liwagu River, 1490 m, 3.IX.1988, A. Smetana leg.; 2 es., Borneo, Sabah, Crocker Rge. N.P., Hwy. A 3, Km 48 cca, 1000 m, 5.IX.1988, leg. A. Smetana.

    DISTRIBUZIONE. La Réunion, Sri Lanka, Malaysia, Indonesia, Nuova Guinea e Filippine, Vietnam. Nuova per il Borneo.

Stenomastax tuberculicollis (Kraatz, 1859)   Figg. 42-45
Homalota tuberculicollis Kraatz, 1859: 33
Stenomastax tuberculicollis: Cameron, 1939: 177; Pace, 1998: 142
        1 ♂ e 1 ♀, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 485 m, 29.VIII.1988, leg.
A. Smetana.
        DISTRIBUZIONE. Sri Lanka, India, Singapore, Cina, Vietnam. Già nota del
Borneo. Questa specie è qui illustrata per la prima volta.

Stenomastax nigrescens (Fauvel, 1905)
Homalota nigrescens Fauvel, 1905: 147
Stenomastax nigrescens: Cameron, 1939:170; Pace, 1992: 120: Pace, 1998: 142; Pace, 2000: 41
        5 es., Sabah, M. Kinabalu N.P., Poring Hot Springs, 485-495 m, 29-30.VIII.1988, leg.
A. Smetana.
        DISTRIBUZIONE. India, Sumatra, Singapore, Malaysia, Giava, Sabah, Cina, Thai-
landia, Sumatra, Malaysia, Vietnam.

Coenonica soror Cameron, 1933
Coenonica soror Cameron, 1933: 354
        54 es., Borneo, Sabah, M. Kinabalu N.P., below Layang Layang, 2600 m, 2-8.V.1987,
int. trap, leg. A. Smetana; 35 es., Borneo, Sabah, M. Kinabalu N.P., below Laban Rata, 3150 m,
7.VIII.1988, leg. A. Smetana.
        DISTRIBUZIONE. Borneo: Mt. Kinabalu.

Coenonica borneensis Cameron, 1933
Coenonica borneensis Cameron, 1933: 353
        1 ♀, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 485 m, 29.VIII.1988, A. Smetana leg.
        DISTRIBUZIONE. Borneo: Mt. Kinabalu.

Mimopisalia borneensis (Cameron, 1933)
Leptusa borneensis Cameron, 1933: 355
Mimopisalia borneensis: Pace, 1984b: 899
        5 es., Borneo-Sabah, Mt. Kinabalu, 2600 m, 1.V.1987, leg. Burckhardt & Löbl; 5 es.,
Borneo-Sabah, Mt. Kinabalu, 3150-3200 m, 3.V.1987, leg. Burckhardt & Löbl; 2 es., Sabah, Mt.
Kinabalu, 3300 m, Panar Laban, 4.V.1987, leg. Burckhardt & Löbl; 5 3 es., Sabah, Mt. Kinabalu
Nat. Pk., Paka Cave, 2995 m, 5.V.1987, leg. A. Smetana; 2 es., Sabah, M. Kinabalu N.P., below
Laban Rata, 3150 m, 5.V.1987, leg. A. Smetana; 8 es., Sabah, Mt. Kinabalu N.P., above Gunting
Lagadan, 3400 m, 6.V.1987, A. Smetana leg.
        DISTRIBUZIONE. Alte quote del M. Kinabalu.

Mimopisalia kinabaluensis Pace, 1989
Mimopisalia kinabaluensis Pace, 1989: 6
        54 es., Sabah, Mt. Kinabalu N.P., 2600 m, 1.IV.1987, Burckhardt & Löbl leg.; 13 es.,
Borneo, Sabah, Mt. Kinabalu N.P., below Layang Layang, 2590 m, 1.V.1987, A. Smetana leg.;
6 es., Borneo, Sabah, Mt. Kinabalu, 2600 m, 2.V.1987, Burckhardt & Löbl leg.; 4 es., Borneo-
Sabah, Mt. Kinabalu, 3150-3200 m, 3.V.1987, leg. Burckhardt & Löbl.; 3 es., Sabah, Mt.
Kinabalu, 3300 m, Panar Laban, 4.V.1987, leg. Burckhardt & Löbl.; 36 es., Sabah, Mt. Kinabalu
Nat. Pk., Paka Cave, 2995 m, 5-6.V.1987, leg. A. Smetana.
        DISTRIBUZIONE. Alte quote del M. Kinabalu.

Neosilusa ceylonica (Kraatz, 1857)
Stenusa ceylonica Kraatz, 1857: 8
Plagiusa ceylonica: Cameron, 1939: 167
Neosilusa ceylonica: Pace 1984a: 15; Pace 1993: 71

1 ♂ e 1 ♀, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 485 m, 25.VIII.1988, A. Smetana leg.; 3 ♂ ♂, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 485 m, 29.VIII.1988, A. Smetana leg.; 1 es., Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 485 m, 30.VIII.1988, A. Smetana leg.

DISTRIBUZIONE. Mascarene, India, Malesia, Cina e Giappone. Nuova per il Borneo.

Neosilusa tropica (Bernhauer, 1915)

Silusa (Plagiusa) tropica Bernhauer, 1915: 28
Neosilusa tropica Pace, 1984a: 17

1 es., Sabah, Poring Hot Springs, 500 m, 7.V.1987, leg. Burckhardt & Löbl; 1 es., Sabah, Poring Hot Springs, 500 m, 13.V.1987, leg. Burckhardt & Löbl.

DISTRIBUZIONE. Sumatra, Mascarene (Pace, 1984a) e Madagascar. Nuova per il Borneo.

Neomalota cingulata Cameron, 1920

Neomalota cingulata Cameron, 1920: 245

9 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 500 m, 6.V.1987, Burckhardt & Löbl leg.; 9 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 500 m, 7.V.1987, Burckhardt & Löbl leg.; 4 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 500 m, 9.V.1987, Burckhardt & Löbl leg.; 6 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, nr. Bat Cave, 600 m, 10.V.1987, Burckhardt & Löbl leg.; 10 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 500 m, 11.V.1987, Burckhardt & Löbl leg.; 1 ea., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, 500 m, 13.V.1987, Burckhardt & Löbl leg.

DISTRIBUZIONE. Malaysia, Singapore. Nuova per il Borneo.

Neocoenonica antennalis (Cameron, 1936)

Astilbus antennalis Cameron, 1936: 18
Drusilla antennalis Hammond, 1984: 209
Neocoenonica antennalis: Cameron, 1950: 94

2 es. Sabah, Crocker Range, 1550-1650 m, 16.V.1987, leg. Burckhardt & Löbl; 9 es., Sabah, Crocker Range, 1200 m, Km 63 r.te Kota Kinabalu-Tambunan, 19.V.1987, leg. Burckhardt & Löbl.

DISTRIBUZIONE. Malaysia, Sumatra. Già nota del Borneo.

DESCRIZIONI

Stenomastax longacrista sp. n.   Figg. 1-5

Holotypus ♂, Borneo, Sabah, Danum Valley F.S., 85 Km W Lahad Datu, 100 m, 23.VI-II.1988, D.E. Bright collector (MHNG).
Paratypus: 1 ♀, stessa provenienza.

DESCRIZIONE. Lungh. 1,2 mm. Corpo debolmente lucido e bruno-rossiccio, con elitre brune; antenne bruno-rossicce con antennomero basale giallo-rossiccio; zampe gialle. La punteggiatura del capo è fittissima a punti contigui fra loro. La granulosità del pronoto e delle elitre è indistinta o confusa, quella dell'addome è distinta, rada sugli uroterghi liberi quarto e quinto. Il capo presenta un'impressione occipitale, il pronoto un ampio solco mediano. La reticolazione del pronoto è netta e fine, quella delle elitre e dell'addome è distinta. Edeago figg. 2-3, sesto urotergo libero del ♂ fig. 4, spermateca fig. 5.

COMPARAZIONI. Per la taglia corporea minuta e per l'occipite impresso, la nuova specie è ben distinta da quelle note del Borneo, quali *S. nigrescens* (Fauvel, 1905),

S. variicornis (Kraatz, 1859) e *S. borneensis* Cameron, 1933. Per la forma dell'edeago non esiste stretta affinità tassonomica con le tre specie citate. Esistono, al contrario, con *S. deharvengi* Pace, 1990, delle Filippine, ma l'edeago della nuova specie è meno sviluppato, con "crista apicalis" sporgente (bassa in *deharvengi*) e la spermateca è subsferica (ovale in *deharvengi*).

ETIMOLOGIA. Il nome della nuova specie significa "lunga cresta". È quella prossimale dell'edeago.

Stenomastax perpusilla sp. n.   Figg. 6-9

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ 1560 m, 23.IV.1987, leg. A. Smetana, (MHNG).
Paratypus: 1 ♀, Borneo, Sabah, Mt. Kinabalu N.P., HQ at Liwagu Rv., 1500 m, 16.V.1987, A. Smetana leg.

DESCRIZIONE. Lungh. 1,7 mm. Avancorpo opaco, addome lucido. Corpo bruno, con pigidio bruno-rossiccio; antenne rossicce con l'antennomero basale e l'undicesimo giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo è composta di punti tra loro contigui. La granulosità del pronoto è confusa, quella delle elitre è superficiale e quella dell'addome è distinta. La reticolazione del pronoto è evidente, quella delle elitre è svanita e quella dell'addome è distinta. Edeago figg. 7-8, sesto urotergo libero del ♂ fig. 9.

COMPARAZIONI. Per la forma dell'edeago, la nuova specie è affine a *S. longacrista* sp. n. sopra descritta, ma l'undicesimo antennomero è giallo-rossiccio (bruno-rossiccio in *longacrista*) e l'edeago è dilatato in visione ventrale. Quest'ultimo carattere non si riscontra nemmeno in *S. deharvengi* Pace, 1990, delle Filippine, un'altra specie sua affine.

ETIMOLOGIA. Il nome della nuova specie significa "piccolissima" e deriva dalla ridotta taglia corporea.

### *Stenomastax bitruncata* sp. n.   Figg. 10-14

Holotypus ♂, Sabah, Mt. Kinabalu, 1750 m, 21.IV.1987, leg. Burckhardt & Löbl (MHNG).
Paratypi: 2 ♀♀, Sabah, Poring Hot Springs, 600 m, Bat Cave, 10.V.1987, leg. Burckhardt & Löbl.

DESCRIZIONE. Lungh. 1,8 mm. Corpo giallo-rossiccio, con capo, elitre e quarto urite libero bruno-rossicci; antenne bruno-rossicce con i due antennomeri basali e l'undicesimo giallo-rossicci; zampe gialle. La punteggiatura del capo è fitta e confusa. La granulosità del pronoto è indistinta, quella delle elitre è confusa e quella degli uroterghi distinta. La reticolazione del capo e del pronoto è netta e quella delle elitre e dell'addome è distinta. Edeago figg. 11-12, sesto urotergo libero del ♂ fig. 14, spermateca fig. 13.

COMPARAZIONI. Per la parte dilatata dell'edeago, in visione ventrale, la nuova specie potrebbe essere tassonomicamente affine a *S perpusilla* sp. n. sopra descritta, ma la forma del margine posteriore del sesto urotergo libero del ♂ separa nettamente le due specie.

ETIMOLOGIA. La nuova specie prende nome di "tronca due volte" a motivo della presenza di due lobi tronchi al margine posteriore del sesto urotergo libero del ♂.
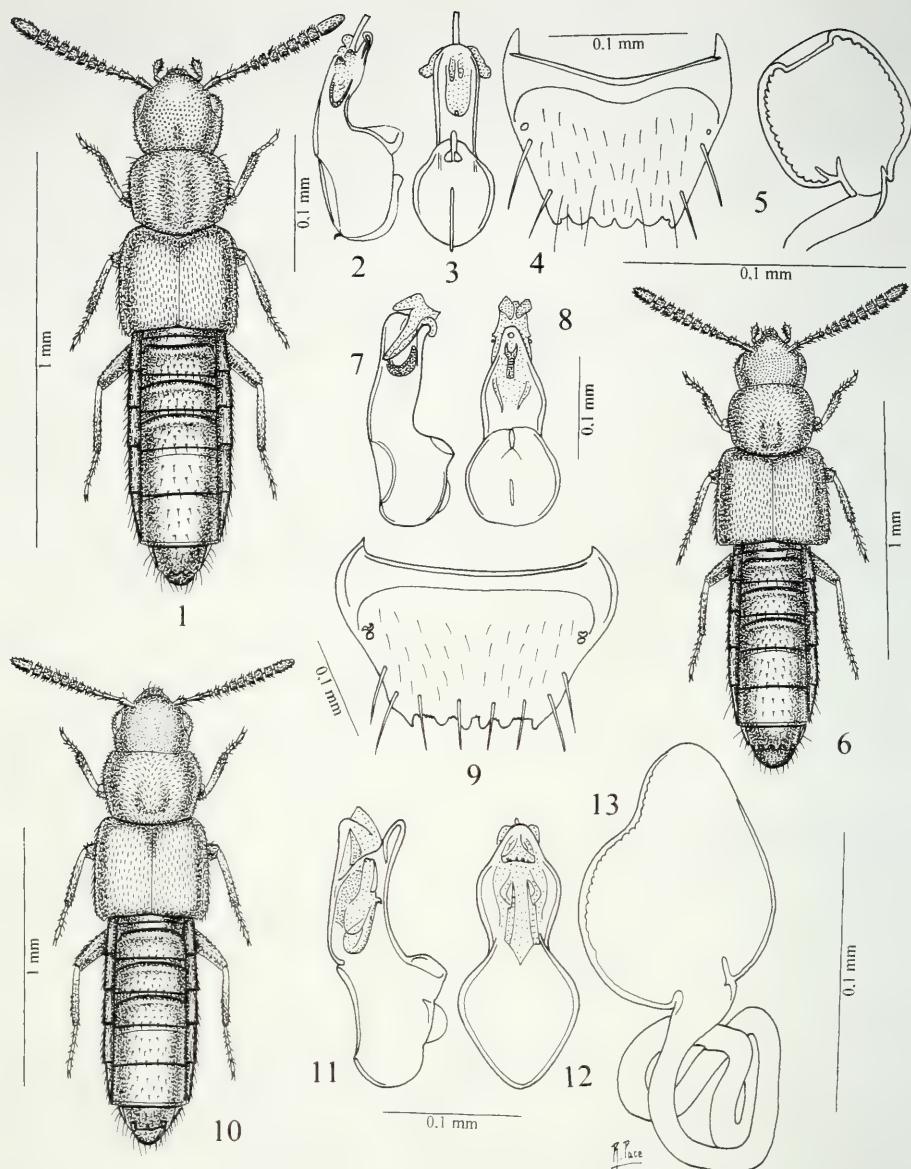
FIGG. 1-13

Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 1-5: *Stenmastax longacrista* sp. n.; 6-9: *Stenomastax perpusilla* sp. n.; 10-13: *Stenomastax bitruncata* sp. n.

Stenomastax pseudoliwaguensis sp. n.   Figg. 15-17

        Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1500 m, 30.IV.1987, leg. A. Smetana (MHNG).

DESCRIZIONE. Lungh. 1,9 mm. Corpo debolmente lucido e rossiccio; antenne rossicce con i due antennomeri basali giallo-rossicci; zampe gialle. La punteggiatura del capo è fitta. Solco frontale profondo. La granulosità del pronoto e delle elitre è indistinta, quella dell'addome è ben visibile. Il pronoto ha un largo solco mediano. Su tutto il corpo la reticolazione è distinta. Edeago figg. 16-17.

COMPARAZIONI. L'edeago della nuova specie è simile a quello di *S. variicornis* (Kraatz, 1859), dello Sri Lanka. Per questo motivo è possibile un' affinità tassonomica tra le due specie. Ma mentre *S. variicornis* presenta il tubulo interno dell'edeago sottile e lungo, quello della nuova specie è largo, robusto e corto. Inoltre il quarto antennomero è trasverso nella nuova specie e largo quanto lungo in *S. variicornis*.

ETIMOLOGIA. Il nome della nuova specie significa "falsa *liwaguensis*". *Stenomastax liwaguensis* è la nuova specie sotto descritta, sua affine per la forma dell'edeago.

Stenomastax liwaguensis sp. n. Figg. 18-21

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1500 m, 25.IV.1987, leg. A. Smetana (MHNG).
Paratypi: 8 es., stessa provenienza ; 1 ♀, Sabah, Poring Hot Springs, 600 m, Bat Cave, 10.V.1987, leg. Burckhardt & Löbl; 1 ♂, Borneo-Sabah, Mt. Kinabalu,1550 m, 23.IV.1987, leg. Burckhardt & Löbl; 1 ♂ e 2 es., Borneo, Sabah, Mt. Kinabalu N.P.,1750 m, 27.IV.1987, Burckhardt & Löbl leg.; 1 es., Borneo-Sabah, Mt. Kinabalu, 1580 m, 27.IV.1987, leg. Burckhardt & Löbl; 10 es., Borneo-Sabah, Mt. Kinabalu, 1550 m, 29.IV.1987, leg. Burckhardt & Löbl; 3 es., Borneo-Sabah, Mt. Kinabalu, 1500 m, 30.IV.1987, leg. Burckhardt & Löbl; 1 ♀, Sabah, Crocker Range, 1550-1650 m, 16.V.1987, leg. Burckhardt & Löbl; 3 es. Sabah, Crocker Range, 1600 m, Km 51 r.te Kota Kinabalu-Tambunan, 18.V.1987, leg. Burckhardt & Löbl; 1 ♂, Borneo-Sabah, Mt. Kinabalu,1500 m, 21.V.1987, leg. Burckhardt & Löbl; 30 es., Borneo-Sabah, Mt. Kinabalu,1150-1900 m, 21-23-24.V.1987, leg. Burckhardt & Löbl; 5 es., Borneo-Sabah, Mt. Kinabalu Nat. Pk., HQ Silau-Silau Tr., 1560 m, 3.VIII.1988, leg. A. Smetana; 32 es., Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1490 m, 10.VIII.1988, leg. A. Smetana; 28 es., Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1520 m, 11.VIII.1988, leg. A. Smetana.

DESCRIZIONE. Lungh. 1,8 mm. Corpo debolmente lucido e rossiccio, con capo, elitre e quarto urite libero bruni; antenne brune con i tre antennomeri basali e l'undicesimo rossicci; zampe gialle. La punteggiatura dell'avancorpo è fittissima. La granulosità dell'addome è distinta. Una reticolazione superficiale copre la superficie degli uroterghi. Edeago figg. 19-20, spermateca fig. 21.

COMPARAZIONI. La nuova specie, per la forma dell'edeago, è affine a *S. pseudoliwaguensis* sp. n. sopra descritta e a *S. variventris* (Kraatz, 1859) dello Sri Lanka. Si distingue da entrambe per la presenza di un robusto sviluppo dell'armatura interna dell'edeago in cui non è distinguibile un tubulo, presente nelle due specie a confronto. L'apice dell'edeago acutissimo e la notevole lunghezza dell'undicesimo antennomero permettono di distinguere ulteriormente la nuova specie da esse.

ETIMOLOGIA. La nuova specie prende nome dalla sua località tipica, Liwagu.

Stenomastax ubahensis sp. n. Figg. 22-24

Holotypus ♂, Borneo-Sabah, Mt. Kinabalu N.P., Summit Trail Pondok Ubah, 2050 m, 26.IV.1987, leg. A. Smetana, (MHNG).

DESCRIZIONE. Lungh. 1,9 mm. Corpo lucido e giallo-rossiccio, con capo ed elitre rossicci; antenne giallo-rossicce; zampe gialle. Il capo presenta un solco discale
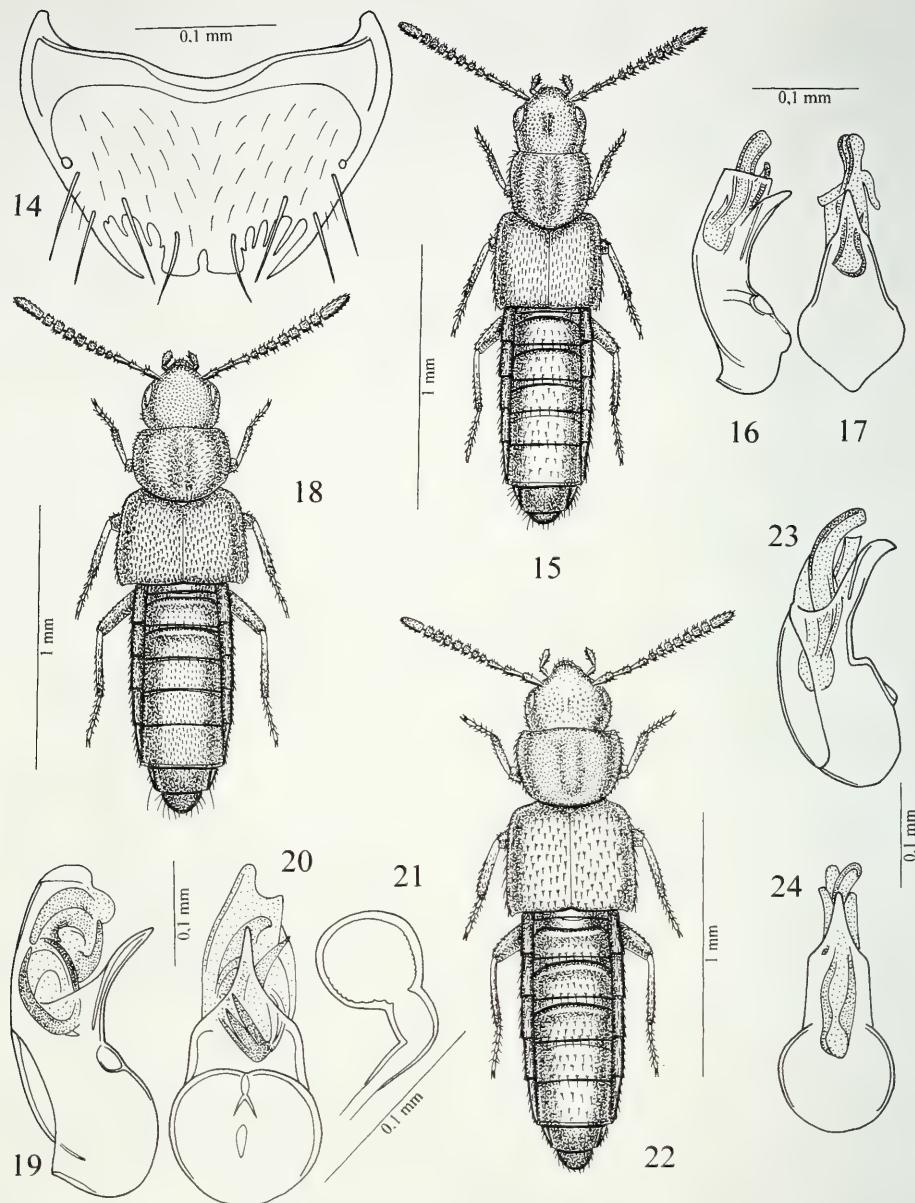
Sesto urotergo libero del ♂, habitus, edeago in visione laterale e ventrale e spermateca. 14: *Stenomastax bitruncata* sp. n.; 15-17: *Stenomastax pseudoliwaguensis* sp. n.; 18-21: *Stenomastax liwaguensis* sp. n.; 22-24: *Stenomastax ubahensis* sp. n.

e punteggiatura fittissima e poco profonda. Quella del pronoto è confusa. La granulosità delle elitre e dell'addome è saliente. Sul corpo la reticolazione è distinta. Edeago figg. 23-24.

COMPARAZIONI. Per la forma dell'edeago, la nuova specie si mostra affine a *S. pseudoliwaguensis* sp. n., sopra descritta. Ma la nuova specie ha apice dell'edeago, in visione laterale, assai largo e non acuto. Inoltre la nuova specie ha pronoto nettamente trasverso, mentre quello di *pseudoliwaguensis* lo è appena.

ETIMOLOGIA. La nuova specie prende nome dalla sua località tipica Ubah.

Stenomastax pugiofora sp. n.   Figg. 25-29

Holotypus ♂, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 485 m, 29.VIII.1988, leg. A. Smetana (MHNG).
Paratypus: 1 ♀, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 495 m, 30.VIII.1988, leg. A. Smetana.

DESCRIZIONE. Lungh. 1,9 mm. Corpo lucido e bruno; antenne brune con antennomero basale giallo-bruno; zampe gialle. Il capo presenta punteggiatura fitta e molto superficiale e un debole solco mediano. La granulosità del pronoto è indistinta, quella delle elitre è assai poco distinta e quella dell'addome è molto saliente sui tre uroterghi basali e superficiale sui restanti. La reticolazione del capo e dell'addome è distinta, quella del pronoto è netta e quella delle elitre è superficiale. Edeago figg. 26-27, sesto urotergo libero del ♂ fig. 29, spermateca fig. 28.

COMPARAZIONI. Per la forma dell'edeago, la nuova specie è sicuramente affine a *S. platygaster* (Kraatz, 1859) (tipi da me esaminati), a larga diffusione in Oriente. Se ne distingue essenzialmente per il margine posteriore del sesto urotergo libero del ♂ che possiede un larghissimo lobo mediano limitato da incavature superficiali (lobo mediano stretto, limitato da profonda incavatura in *platygaster*). Questo caratteristico margine posteriore del sesto urotergo libero del ♂ della nuova specie si riscontra pure in *S. diogenes* Pace, 1998, della Cina, ma questa specie non ha l'apice dell'edeago strettissimo e prolungato come quello della nuova specie.

ETIMOLOGIA. Il nome della nuova specie significa "portatrice di pugnale" perché una parte dell'armatura interna dell'edeago ha forma di pugnale.

*Stenomastax maculiventris* sp. n.   Figg. 30-32

Holotypus ♂, Sabah, Mt. Kinabalu,1750 m, 27.IV.1987, leg. Burckhardt & Löbl (MHNG).

DESCRIZIONE. Lungh. 1,8 mm. Corpo lucido e giallo-rossiccio, con elitre brune e quarto urotergo libero bruno-rossiccio; antenne giallo-rossiccio; zampe gialle. La punteggiatura del capo è fittissima. La granulosità del pronoto e delle elitre è indistinta, quella dell'addome è saliente. La reticolazione è distinta su tutto il corpo. Edeago figg. 31-32.

COMPARAZIONI. Per la forma dell'edeago, la nuova specie si pone tassonomicamente vicino a *S. platygaster* (Kraatz, 1859) (tipi da me esaminati), a larga diffusione in Oriente. Se ne distingue, oltre per il colore nettamente differente del corpo, per l'apice dell'edeago più robusto in visione laterale e non protratto, in visione ventrale.

ETIMOLOGIA. Per la presenza di un anello bruno sull'addome giallo-rossiccio, la nuova specie è chiamata "addome macchiato".
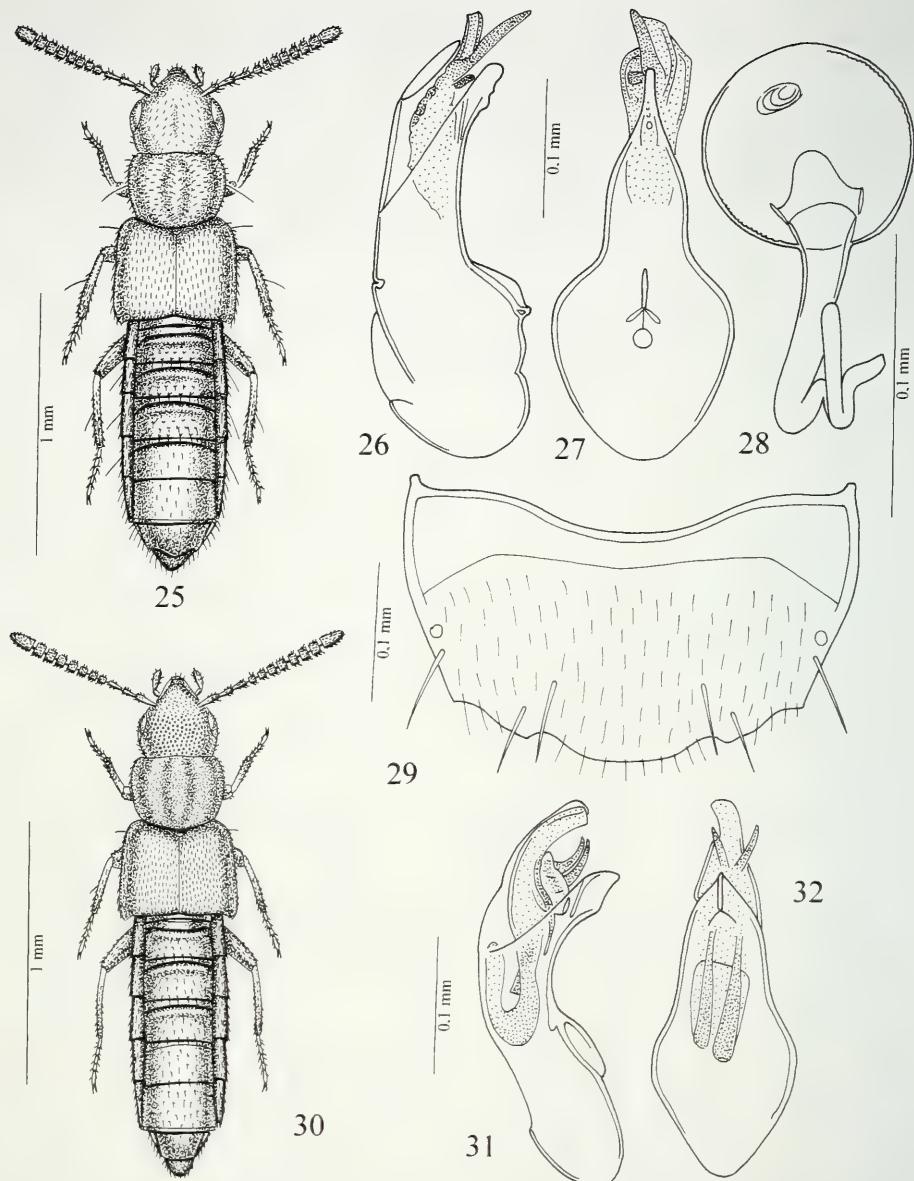
Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 25-29: *Stenomastax pugiofora* sp. n.; 30-32: *Stenomastax maculiventris* sp. n.

Stenomastax hawarensis sp. n.   Figg. 33-36

Holotypus ♂, Borneo, Hawar, VI.1998, leg. Hlavac (MRSN).

DESCRIZIONE. Lungh. 2,1 mm. Pronoto molto opaco, resto del corpo lucido. Capo ed elitre nero-bruni, pronoto bruno-rossiccio, addome giallo-rossiccio con gli uroterghi liberi terzo e quarto rossicci; antenne brune con i due antennomeri basali e l'apice dell'undicesimo bruno-rossicci; zampe gialle. La punteggiatura del capo è ombelicata fittissima e netta, tranne sulle tempie dove è confusa nella reticolazione vigorosa, come quella del pronoto. Largo e profondo è il solco mediano del pronoto. La granulosità delle elitre e dei tre uroterghi basali è saliente, quella sugli uroterghi liberi quarto e quinto è superficiale. La reticolazione del capo è netta, quella delle elitre è superficiale e quella dell'addome è distinta, a maglie poligonali irregolari. Edeago figg. 34-35, margine posteriore del sesto urotergo libero del ♂ fig. 36.

COMPARAZIONI. La nuova specie presenta edeago simile a quello di *S. baliensis* Pace, 1986, dell'isola di Bali. Se ne distingue per un evidente tubulo interno dell'edeago, non distinto in *baliensis,* e per il margine posteriore del sesto urotergo libero del ♂ con cinque lobi tra due spine laterali e non tre lobi tra due spine, come in *baliensis.*

ETIMOLOGIA. La nuova specie prende nome dalla sua località tipica Hawar.

Stenomastax sericina sp. n.   Figg. 37-39

Holotypus ♂, Sabah, Poring Hot Springs, 500 m, 11.V.1987, leg. Burckhardt & Löbl (MHNG).

DESCRIZIONE. Lungh. 1,6 mm. Avancorpo opaco, addome lucido. Corpo bruno, con pronoto rossiccio e addome giallo-rossiccio, con urotergo libero quarto bruno-rossiccio; antenne rossicce con l'antennomero basale e l'undicesimo giallo-rossicci; zampe gialle. La punteggiatura del capo è distinta e fittissima. La granulosità del pronoto e delle elitre è fittissima, fine e confusa, quella dell'addome è distinta. La reticolazione delle elitre e dell'addome è distinta. Il pronoto presenta un largo solco mediano. Edeago figg. 38-39.

ETIMOLOGIA. La pubescenza del corpo, fine come seta, dà il nome di "simile a seta" alla nuova specie.

COMPARAZIONI. La nuova specie per l'apice del suo edeago, flesso al lato ventrale, appartiene al gruppo di specie a cui fa capo *S. cribrum* (Fauvel, 1878) della Nuova Guinea, ma diffusa anche a Palawan e a Hong Kong. A questo gruppi appartiene anche *S. raptoria* Pace, 1998 della Cina e *S. celebensis* Pace, 1986, di Celebes. La nuova specie si distingue da queste specie per i caratteri dati nella seguente chiave.

1   In visione laterale, tra l'apice dell'edeago e la "crista apicalis", il profilo ventrale è concavo; margine posteriore del sesto urotergo libero del ♂ con sei lunghi denti tra le spine laterali. Lungh. 3,0 mm. Nuova Guinea, Cina, Filippine . . . . *S. cribrum* (Fauvel)

-   In visione laterale, tra l'apice dell'edeago e la "crista apicalis", il profilo ventrale è rettilineo; margine posteriore del sesto urotergo libero del ♂ semplice 2

2   In visione laterale, intercapedine apicale dell'edeago stretta 3
-        In visione laterale, intercapedine apicale dell'edeago larga. Lungh.
         1,6 mm. Borneo . . . . *S. sericina* sp. n.
3   In visione laterale, intercapedine apicale dell'edeago molto più lunga
         che larga; apice dell'edeago strettissimo, in visione ventrale. Lungh.
         2,0 mm. Cina . . . . *S. raptoria* Pace
-        In visione laterale, intercapedine apicale dell'edeago corta e stretta;
         apice dell'edeago non prolungato e stretto, in visione ventrale. Lungh.
         1,9 mm. Celebes . . . . *S. celebensis* Pace

Stenomastax esuriens sp. n.   Figg. 40-41

         Holotypus ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ 1560-1660 m, 24.IV.1987, leg.
A. Smetana, (MHNG).
         Paratypi: 1 ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ 1495 m, 12.VIII.1988, leg. A.
Smetana; 1 ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu River, 1500 m, 1.IX.1988,
A. Smetana leg.
         DESCRIZIONE. Lungh. 1,8 mm. Pronoto molto opaco, resto del corpo lucido.
Corpo bruno con pronoto rossiccio e addome giallo-rossiccio; antenne bruno-rossicce
con i due antennomeri basali giallo-rossicci; zampe gialle. La punteggiatura del capo è
fittissima, quella del pronoto è indistinta. La granulosità delle elitre è fittissima. I due
uroterghi basali presentano granuli allineati trasversalmente presso il solco basale. La
reticolazione del pronoto e dell'addome è distinta. Spermateca fig. 41.
         ETIMOLOGIA. Il nome della nuova specie significa "affamata".
         COMPARAZIONI. Per la forma della spermateca, la nuova specie si colloca tasso-
nomicamente vicino a *S. parallela* Cameron, 1941, delle Filippine (holotypus ♀ da me
esaminato). Se ne distingue per i caratteri dati nella seguente chiave.

1   Fossette basali del pronoto strette; elitre giallo-rossicce; base del bulbo
         distale della spermateca, larga ed emisferica. Lungh. 1,8 mm. Filippine
         . . . . *S. parallela* Cameron
-        Fossette basali del pronoto larghe; elitre brune; base del bulbo distale
         della spermateca, stretta e troncoconica. Lungh. 1,8 mm. Borneo
         . . . . *S. esuriens* sp. n.

Stenomastax terminicornis sp. n.   Figg. 46-47

         Holotypus ♀, Borneo-Sabah, M. Kinabalu N.P., Summit Trail, 1890 m, (data mancante),
leg. A. Smetana, (MHNG).
         DESCRIZIONE. Lungh. 1,9 mm. Corpo lucido e bruno-rossiccio, con elitre brune
e addome rossiccio, con quarto urite libero bruno; antenne brune, con l'antennomero
basale rossiccio, il nono e il decimo rossicci e l'undicesimo giallo; zampe giallo-
rossicce. La punteggiatura del capo e delle elitre è fittissima e superficiale. La granu-
losità del pronoto è confusa nella reticolazione, quella dell'addome è fitta. La retico-
lazione del pronoto è evidente, quella dell'addome è estremamente superficiale.
Spermateca fig. 47.
         COMPARAZIONI. La nuova specie presenta il quarto antennomero più lungo che
largo, come in *S. borneensis* Cameron, 1933, pure del Borneo. Ma questa specie
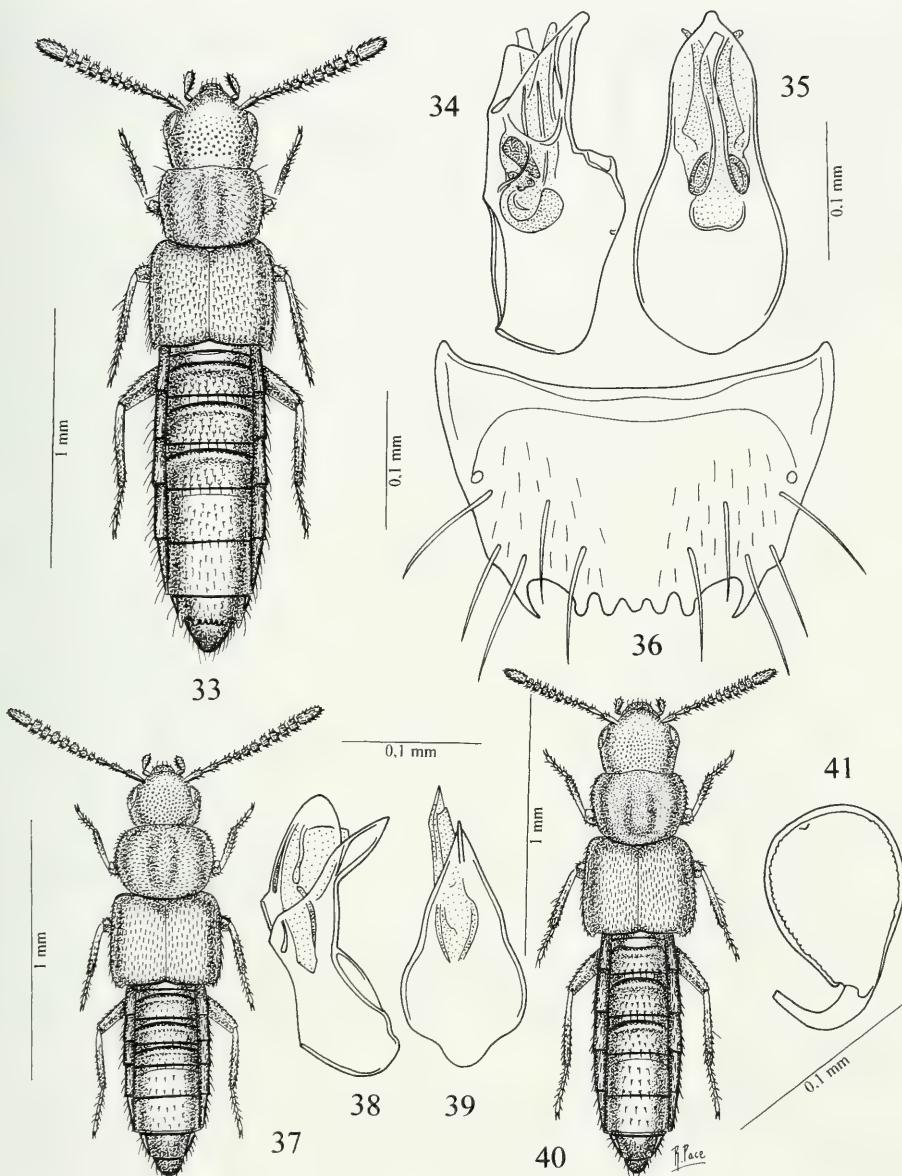
FIGG. 33-41

Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 33-36: *Stenomastax hawarensis* sp. n.; 37-39: *Stenomastax sericina* sp. n.; 40-41: *Stenomastax esuriens* sp. n.

presenta antenne brune con l'undicesimo antennomero giallo e non antenne intera-
mente giallo-rossicce come in *borneensis*. Inoltre il capo della nuova specie è bruno-
rossiccio e non nero come in *borneensis*.

ETIMOLOGIA. Il nome della nuova specie mette in risalto il suo carattere più
distintivo: il colore giallo dell'undicesimo antennomero, in contrasto con i contigui
antennomeri rossicci e bruno-rossicci.

Stenomastax pseudonigrescens sp. n.   Figg. 48-51

Holotypus ♂, Sabah, Borneo, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 485 m, 29.VI-
II.1988, leg. A. Smetana (MHNG).
Paratypus: 1 ♀, stessa provenienza.

DESCRIZIONE. Lungh. 2,0 mm. Corpo debolmente lucido e bruno-rossiccio, con
terzo posteriore delle elitre bruno e addome giallo-rossiccio con il quarto urite libero e
la base del quinto bruni; antenne giallo-rossicce; zampe gialle. La punteggiatura del
capo e del pronoto è distinta. La granulosità delle elitre è confusa nella distinta retico-
lazione. La reticolazione dell'addome è evidente come la sua granulosità. Il capo e il
pronoto presentano reticolazione distinta. Spermateca fig. 48, edeago figg. 50-51.

COMPARAZIONI. La nuova specie presenta elitre giallo-rossicce come quelle di
S. nigrescens (Fauvel, 1905), dell'India, Bengala, Sumatra e Malesia. Ma quest'ultima
specie ha capo e pronoto neri. Per la forma dell'edeago la nuova specie si avvicina
tassonomicamente maggiormente a *S. cribrum* (Fauvel, 1878), della Nuova Guinea,
che a *nigrescens*. Ma la nuova specie, oltre a presentare sei lunghi denti mediani al
margine posteriore del sesto urotergo libero del ♂, presenta l'intercapedine apicale
dell'edeago nettamente più lunga e stretta (larga e corta in *cribrum*).

ETIMOLOGIA. Il nome della nuova specie significa "falsa *nigrescens*".

Stenomastax sphaeratheca sp. n.   Figg. 52-53

Holotypus ♀, Borneo, Sabah, Mt. Kinabalu Nat.Pk., HQ Liwagu Riv. trail, 1500-1550
m, 27.IV.1987, A. Smetana leg. (MHNG).

DESCRIZIONE. Lungh. 1,8 mm. Corpo lucido e bruno-rossiccio, con elitre brune
e addome giallo-rossiccio con quarto urite libero rossiccio; antenne giallo-rossicce con
undicesimo antennomero giallo; zampe gialle. La punteggiatura del capo è fittissima.
La granulosità del pronoto, elitre e addome è fine. Ben visibile è la reticolazione del
pronoto e delle elitre. Spermateca fig. 53.

COMPARAZIONI. Per la forma della spermateca, la nuova specie sembra affine a
S. cribrum (Fauvel, 1878). Ma la dimensione della spermateca è nettamente differente,
minuscola e non di grande sviluppo come quella di *S. cribrum*. Inoltre, nella nuova
specie mancano le lunghe setole laterali isolate sulle tibie, pronoto, elitre e addome,
presenti in *S. cribrum*.

ETIMOLOGIA. Il nome della nuova specie significa "spermateca sferica".

Stenomastax muluensis sp. n.   Figg. 54-55

Holotypus ♀, Borneo, Sarawak, Mulu Nat. Park, leg H. Franz (NHMW).

DESCRIZIONE. Lungh. 1,7 mm. Avancorpo debolmente opaco, addome lucido.
Corpo bruno-rossiccio, con addome giallo-rossiccio; antenne brune con i due anten-
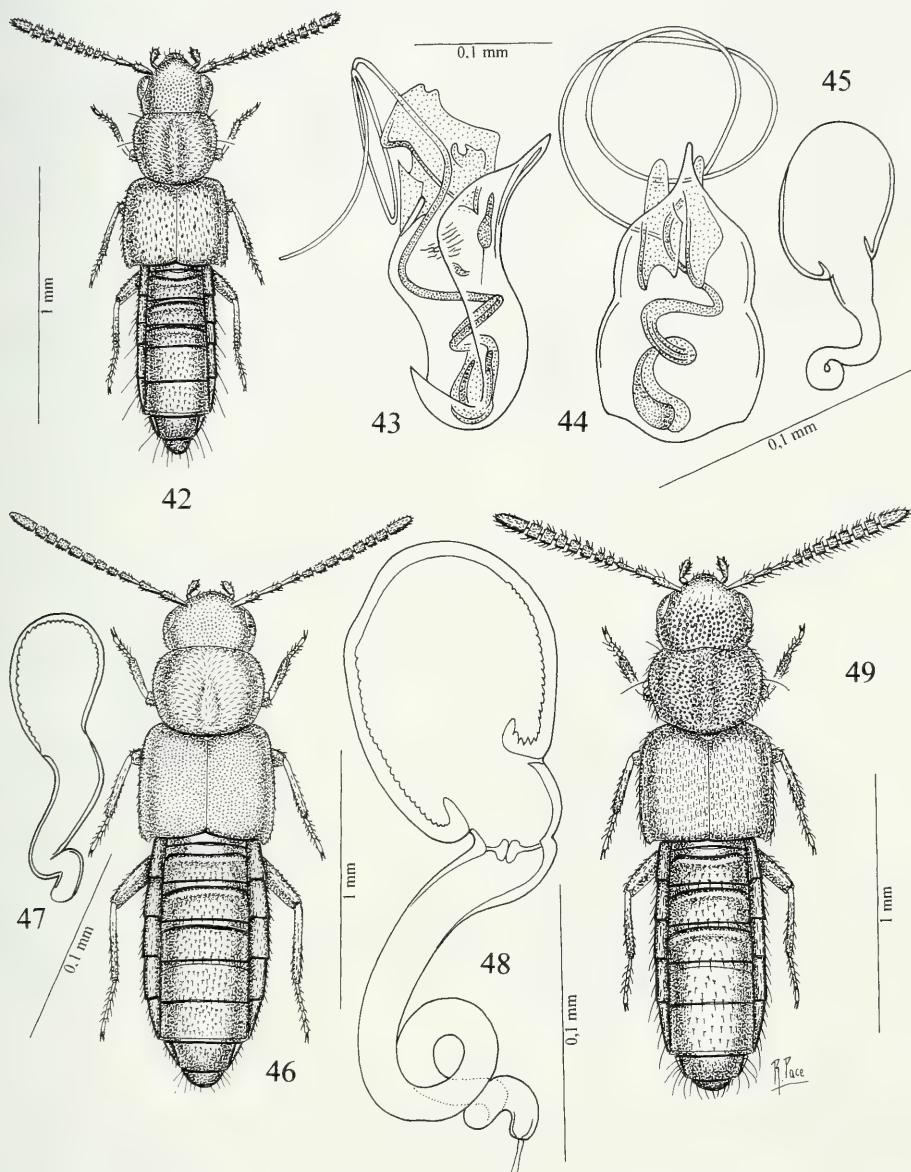
FIGG. 42-49

Habitus, edeago in visione laterale e ventrale e spermateca. 42-45: *Stenomastax tuberculicollis* (Kraatz) del Mt. Kinabalu; 46-47: *Stenomastax terminicornis* sp. n.; 48-49: *Stenomastax pseudonigrescens* sp. n.

nomeri basali bruno-rossicci; zampe giallo-rossicce. La punteggiatura dell'avancorpo è fittissima e distinta. La granulosità dell'addome è superficiale. Assente è la reticolazione dell'addome. Spermateca fig. 55.

COMPARAZIONI. La nuova specie, per la forma della spermateca, sembra affine a *S. cribrum* (Fauvel, 1878). Se ne distingue per la presenza di strette spire prossimali, assai ampie in *cribrum*.

ETIMOLOGIA. La nuova specie prende nome dal Parco Nazionale del Monte Mulu, sua località tipica.

Stenomastax myllaenatheca sp. n.   Figg. 56-57

Holotypus ♀, Mt. Kinabalu, 1580 m, 27.IV.1987, Burckhardt & Löbl leg. (MHNG).

DESCRIZIONE. Lungh.1,6 mm. Corpo lucido e giallo-bruno, con addome giallo sporco; antenne brune con i due antennomeri basali e l'undicesimo rossicci, zampe gialle. La punteggiatura del capo è netta e fittissima. La granulosità del pronoto e dell'addome è fine e quella delle elitre è fitta. La reticolazione del pronoto è distinta, quella dell'addome è superficiale. Il solco mediano del pronoto è bruscamente allargato all'indietro. Spermateca fig. 57.

COMPARAZIONI. Una spermateca che presenta numerose spire prossimali come quella della nuova specie, si osserva anche in *S. nigrescens* (Fauvel, 1905). Ma questa specie ha il bulbo distale di quest'organo fortemente oblungo.

ETIMOLOGIA. La forma della spermateca è simile a quella di alcune specie del genere *Myllaena*. Per questo motivo la nuova specie è chiamata "spermateca di *Myllaena*".

Stenomastax terminalis sp. n.   Figg. 58-59

Holotypus ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Riv., 1500 m, 25.IV.1987, A. Smetana leg. (MHNG).
Paratypi: 2 ♀ ♀, Borneo, Sabah, Mt. Kinabalu, 1900 m, 26.IV.1987, Burckhardt & Löbl leg.

DESCRIZIONE. Lungh. 1,8 mm. Corpo lucido e giallo-bruno; antenne brune con i due antennomeri basali rossicci e i terminali dal nono gialli; zampe gialle. La punteggiatura del capo è ombelicata e fittissima. La granulosità del pronoto e delle elitre è confusa nella netta reticolazione, quella dell'addome è distinta. Spermateca fig. 59.

COMPARAZIONI. Per la forma della spermateca, la nuova specie si pone tassonomicamente vicino a *S. myllaenatheca* sp. n., sopra descritta e a *S. nigrescens* (Fauvel, 1905). Se ne distingue per avere i tre antennomeri apicali gialli e per il bulbo distale della spermateca nettamente meno sviluppato di quello di entrambe.

ETIMOLOGIA. Il nome "terminale" della nuova specie, allude agli antennomeri apicali di colore nettamente differente da quello dei precedenti.

Stenomastax fallax sp. n.   Figg. 60-61

Holotypus ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 480 m, 15.V.1987, leg. A. Smetana (MHNG).
DESCRIZIONE. Lungh. 1,9 mm. Corpo lucido e giallo-rossiccio, con capo rossiccio ed elitre bruno-rossicce; antenne bruno-rossicce con i due antennomeri basali
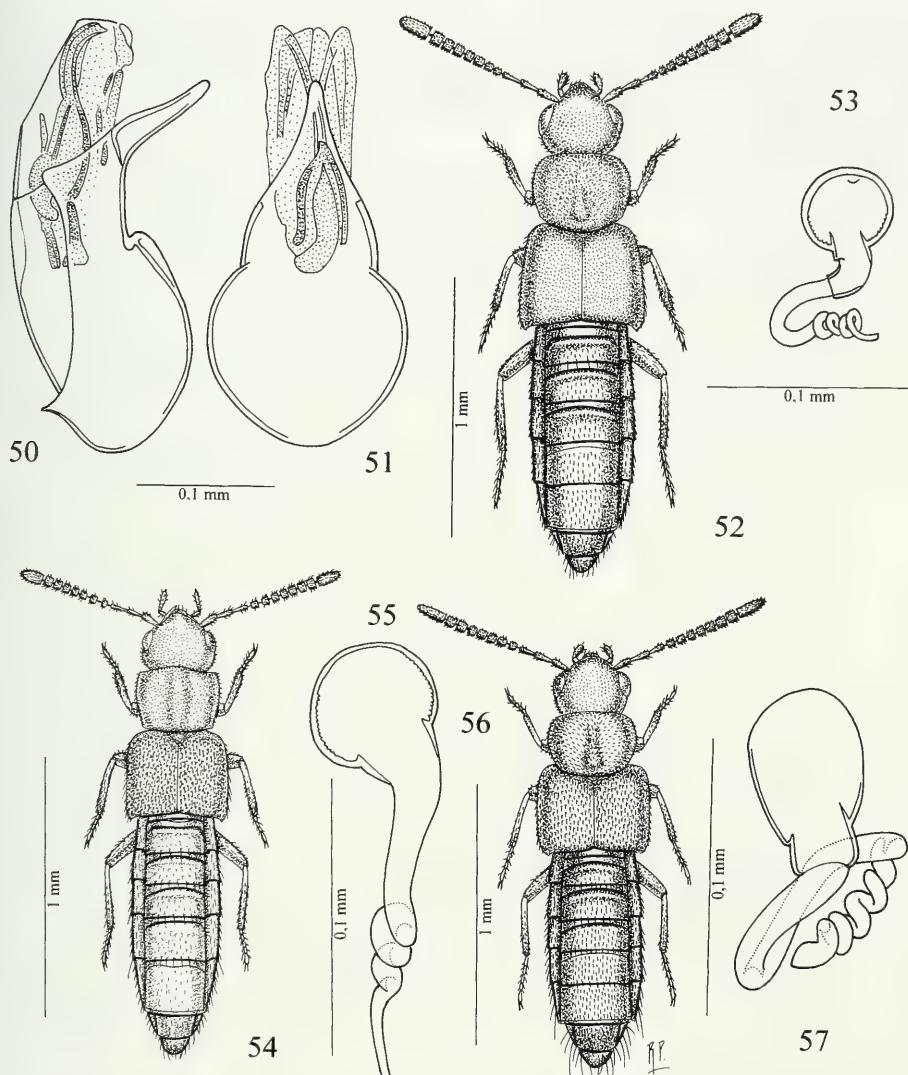
FIGG. 50-57

Edeago in visione laterale e ventrale, habitus e spermateca. 50-51: *Stenomastax pseudonigrescens* sp. n.; 52-53: *Stenomastax sphaeratheca* sp. n.; 54-55: *Stenomastax muluensis* sp. n.; 56-57: *Stenomastax myllaenatheca* sp. n.

rossicci e apice dell'undicesimo gialli; zampe gialle. La punteggiatura del capo e la granulosità del pronoto sono indistinte. La granulosità delle elitre è poco distinta e quella dell'addome è fine. La reticolazione del capo è netta, quella del pronoto è vigorosa e quella delle elitre è distinta. Spermateca fig. 61.

COMPARAZIONI. La nuova specie, per la forma del pronoto, più stretto in avanti che all'indietro, è specie unica nel genere. L'esame della forma della ligula e altre parti

boccali, oltre a quello della formula tarsale, portano ad attribuire la nuova specie a *Stenomastax*.

ETIMOLOGIA. Il nome della nuova specie significa "ingannevole" perché per la forma del pronoto essa poteva essere attribuita al genere *Placusa*, ma l'esame delle parti boccali esclude tale attribuzione.

CHIAVE DEI ♂ ♂ DELLE SPECIE DEL BORNEO DEL GENERE *STENOMASTAX*

1   Quarto antennomero più lungo che largo o lungo quanto largo; decimo antennomero non o poco trasverso 2

-       Quarto a decimo antennomero trasversi 3

2   Quarto antennomero più lungo che largo; elitre brune; tubulo interno dell'edeago corto e robusto; bulbo distale della spermateca molto oblungo, con parte prossimale descrivente numerose e strette spire. Lungh. 2,4 mm. Dall'India al Borneo . . . . *S. nigrescens* (Fauvel)

-       Quarto antennomero lungo quanto largo; elitre giallo-brune; tubulo interno dell'edeago lungo e sottile; bulbo distale della spermateca subsferico, con parte prossimale descrivente poche e larghe spire. Lungh. 1,9 mm. Dalle Mascarene al Borneo . . . . *S. variventris* (Kraatz)

3   Parte distale delle antenne unicolore 7

-       Parte distale delle antenne bicolore 4

4   Corpo unicolore bruno, con pigidio bruno-rossiccio. Lungh. 1,7 mm. Borneo . . . . *S. perpusilla* sp. n.

-       Corpo bicolore bruno e giallo-rossiccio 5

5   Addome unicolore giallo-rossiccio. Lungh. 1,6 mm. Borneo . *S. sericina* sp. n.

-       Addome giallo-rossiccio, con fascia posteriore bruna 6

6   Undicesimo antennomero più lungo dei tre precedenti riuniti; largo solco mediano del pronoto; sesto urotergo libero del ♂ senza lobi e spine al margine posteriore. Lungh. 1,8 mm. Borneo . . . . *S. liwaguensis* sp. n.

-       Undicesimo antennomero più corto dei tre precedenti riuniti; impressione mediana posteriore del pronoto; sesto urotergo libero del ♂ con due lobi tronchi e varie spine al margine posteriore. Lungh. 1,8 mm. Borneo . . . . *S. bitruncata* sp. n.

7   Corpo unicolore bruno o rossiccio 8

-       Corpo bicolore 9

8   Corpo bruno, con pronoto nettamente trasverso e con lunghe setole isolate laterali sulle tibie, pronoto e addome. Lungh. 1,9 mm. Borneo . . . . *S. pugiofera* sp. n.

-       Corpo rossiccio, con pronoto appena trasverso; assenza di lunghe setole isolate ai lati del corpo. Lungh. 1,8 mm. Borneo . . *S. pseudoliwaguensis* sp. n.

9   Antenne brune con base rossiccia o giallo-rossiccia 10

-       Antenne unicolori giallo-rossicce 12

10   Punteggiatura del capo indistinta; elitre giallo-rossicce; margine posteriore del sesto urotergo libero del ♂ senza denti o lobi. Lungh. 2,1 mm. Sri Lanka, India, Cina, Vietnam, Singapore, Giava, Borneo . . . . *S. tuberculicollis* (Kraatz)

-     Punteggiatura del capo da distinta a forte; elitre brune; margine pos-
      teriore del sesto urotergo libero del ♂ con denti e lobi 11

11   Capo, pronoto e addome bruno-rossicci; margine posteriore del sesto
      urotergo libero del ♂ con quattro lobi semicircolari tra le spine laterali
      smussate. Lungh. 1,2 mm . . . . *S. longacrista* sp. n.

-     Solo il pronoto bruno-rossiccio, il capo è nero-bruno; margine posteri-
      ore del sesto urotergo libero del ♂ con cinque lobi allungati tra le acute
      spine laterali. Lungh. 2,1 mm. Borneo . . . . *S. hawarensis* sp. n.

12   Addome unicolore giallo-rossiccio; un solco discale del capo. Lungh.
      1,9 mm. Borneo . . . . *S. ubahensis* sp. n.

-     Addome bicolore giallo-rossiccio, fascia bruna o bruno-rossiccia 13

13   Capo e pronoto giallo-rossiccio; tubulo interno dell'edeago forte.
      Lungh. 1,8 mm. Borneo . . . . *S. maculiventris* sp. n.

-     Capo e pronoto bruno-rossicci; tubulo interno dell'edeago sottile.
      Lungh. 2,0 mm. Borneo . . . . *S. pseudonigrescens* sp. n.

CHIAVE DELLE ♀ ♀ DELLE SPECIE DEL BORNEO DEL GENERE *STENOMASTAX*

1   Quarto antennomero più lungo che largo o lungo quanto largo; decimo
      antennomero non o poco trasverso 2

-     Quarto a decimo antennomero trasversi 7

2   Quarto antennomero più lungo che largo 3

-     Quarto antennomero lungo quanto largo 5

3   Antenne unicolori bruno-giallicce; bulbo distale della spermateca molto
      allungato. Lungh. 2,4 mm. Dall'India al Borneo . . . . . . *S. nigrescens* (Fauvel)

-     Parte apicale delle antenne bicolore; bulbo distale della spermateca poco
      allungato 4

4   Decimo antennomero lungo quanto largo; parte prossimale della sperma-
      teca descrivente due sinuosità. Lungh. 1,9 mm, Borneo . *S. terminicornis* sp. n.

-     Decimo antennomero trasverso; parte prossimale della spermateca de-
      scrivente numerose spire. Lungh. 1,8 mm, Borneo . . . . . *S. terminalis* sp. n.

5   Parte apicale delle antenne bicolore; solco mediano del pronoto solo sul-
      la metà posteriore. Lungh. 1,8 mm. Borneo . . . . *S. sphaeratheca* sp. n.

-     Parte apicale delle antenne unicolore; solco mediano del pronoto dal
      margine anteriore al posteriore 6

6   Capo e pronoto bruno-rossicci. Lungh. 1,9 mm. Dalle Mascarene al
      Borneo . . . . *S. variventris* (Kraatz)

-     Capo nero; pronoto giallo-rossiccio . Lungh. 2,0 mm. Borneo
      . . . . *S. borneensis* Cameron

7   Antenne unicolori giallo-rossicce. Lungh. 2,0 mm. Borneo
      . . . . *S. pseudonigrescens* sp. n.

-     Antenne bicolori, con apice e base giallo-rossicci o gialli 8

8   Corpo unicolore bruno; lunghissime setole laterali isolate del corpo e
      delle tibie. Lungh. 1,9 mm. Borneo . . . . *S. pugiofera* sp. n.

-     Corpo bicolore; assenza di lunghissime setole laterali isolate del corpo e
      delle tibie 9

9		Pronoto giallo-rossiccio 10
-		Pronoto bruno-rossiccio o giallo-bruno 13
10		Pronoto più stretto in avanti che all'indietro; bulbo distale della sperma-
		teca perfettamente sferico e molto sviluppato. Lungh. 1,9 mm . . *S. fallax* sp. n.
-		Pronoto più stretto all'indietro che in avanti; bulbo distale della spermateca non
		sferico, se lo è allora è molto poco sviluppato 11
11		Addome unicolore giallo-rossiccio; bulbo distale della spermateca
		ovale. Lungh. 1,8 mm. Borneo . . . . *S. esuriens* sp. n.
-		Addome bicolore rossiccio o giallo-rossiccio con fascia posteriore
		bruna; bulbo distale della spermateca sferico e poco sviluppato o piri-
		forme a grande sviluppo 12
12		Undicesimo antennomero più lungo dei tre antennomeri precedenti
		riuniti; bulbo distale della spermateca sferico e poco sviluppato. Lungh.
		1,8 mm. Borneo . . . . *S. liwaguensis* sp. n.
-		Undicesimo antennomero nettamente più corto dei tre antennomeri
		precedenti riuniti; bulbo distale della spermateca piriforme e molto
		sviluppato. Lungh. 1,8 mm. Borneo . . . . *S. bitruncata* sp. n.
13		Addome unicolore giallo-rossiccio, bruno-rossiccio o giallo sporco 14
-		Addome bicolore bruno-rossiccio con fascia posteriore bruna. Lungh.
		2.1 mm. Sri Lanka, India, Cina, Vietnam, Singapore, Giava, Borneo
		. . . . *S. tuberculicollis* (Kraatz)
14		Addome giallo-rossiccio; parte prossimale della spermateca descrivente
		tre spire. Lungh. 1,7 mm. Borneo . . . . *S. muluensis* sp. n.
-		Addome bruno-rossiccio o giallo sporco; parte prossimale della sper-
		mateca descrivente cinque spire o senza spire 15
15		Capo e pronoto bruno-rossicci; elitre brune; undicesimo antennomero
		unicolore bruno; parte prossimale della spermateca non descrivente
		spire. Lungh. 1,2 mm. Borneo . . . . *S. longecristata* sp. n.
-		Capo, pronoto ed elitre giallo-bruni; undicesimo antennomero bicolore
		bruno con apice rossiccio; parte prossimale della spermateca descrivente
		cinque spire. Lungh. 1,6 mm. Borneo . . . . *S. myllaenatheca* sp. n.

Coenonica Kraatz, 1857
Coenonica Kraatz, 1857: 45
Deralia Cameron, 1920: 238, **syn. n.**

		Per la discussione vedere le comparazioni date per *Coenonica cryptospina* sp. n.

Coenonica fuscipennis (Cameron, 1920), **comb. n.**
Deralia fuscipennis Cameron, 1920: 238

		Per la discussione vedere le comparazioni date per *Coenonica cryptospina* sp. n.

## *Coenonica trilobata* sp. n.						Figg. 62-66

		Holotypus ♂, Sabah, Mt. Kinabalu, 1550 m, 23.IV.1987, leg. Burckhardt & Löbl
(MHNG).
		Paratypus: 1 ♀, Borneo-Sabah, Crocker Ra., 1270 m, Km 60, rte. Kota Kinabalu-
Tambunan, 17.V.1987, leg. Burckhardt & Löbl.
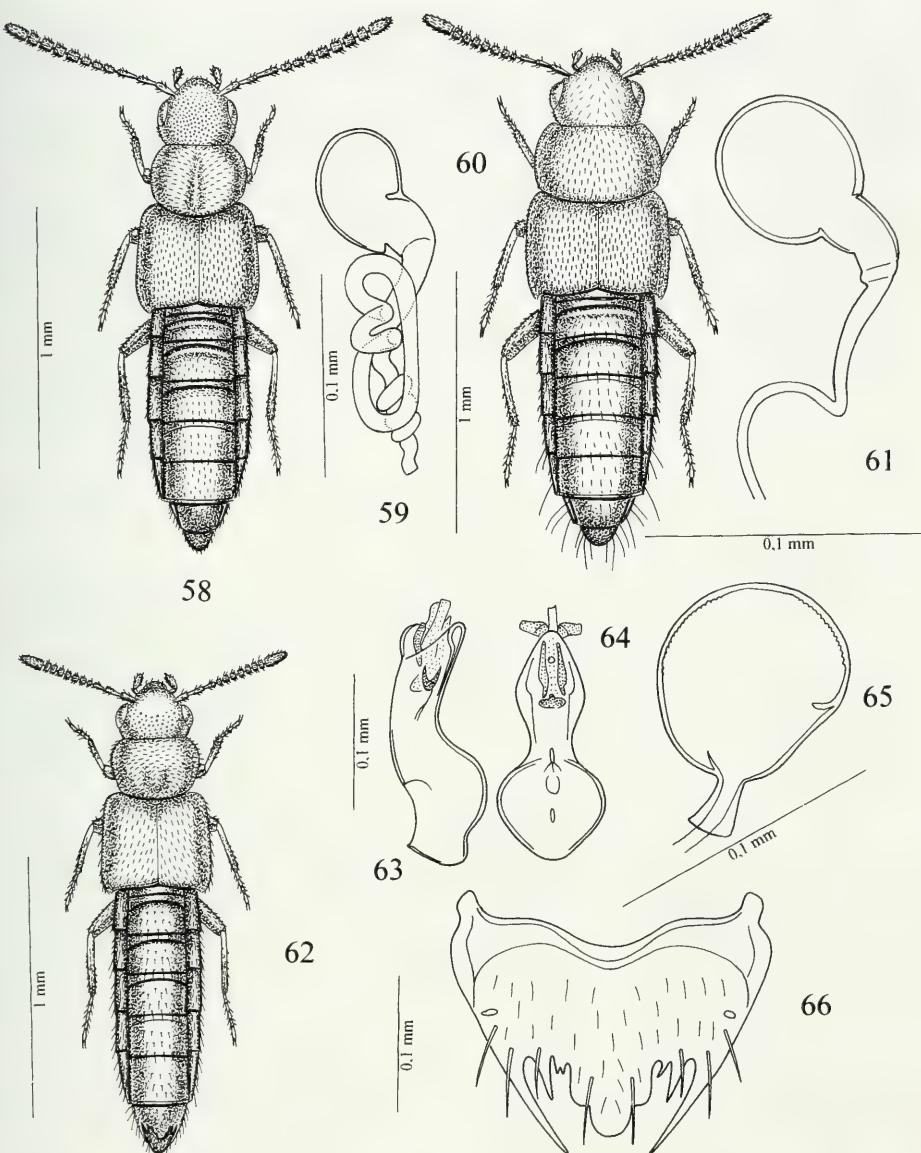
FIGG. 58-66

Habitus, spermateca, edeago in visione laterale e ventrale e sesto urotergo libero del ♂. 58-59: *Stenomastax terminalis* sp. n.; 60-61: *Stenomastax fallax* sp. n.; 62-66: *Coenonica trilobata* sp. n.

DESCRIZIONE. Lungh. 1,8 mm. Corpo lucido e giallo-rossiccio; antenne giallo-rossicce; zampe gialle. La punteggiatura del capo è fitta e assente sulla fronte. La granulosità del pronoto è confusa, quella delle elitre e dell'addome è distinta. La reticolazione del capo e dell'addome è distinta, quella del pronoto è netta e quella delle elitre è superficiale. Edeago figg. 63-64, sesto urotergo libero del ♂ fig. 66, spermateca fig. 65.

COMPARAZIONI. Per avere il corpo non fortemente punteggiato e per la forma del margine posteriore del sesto urotergo libero del ♂, la nuova specie si mostra affine a *C. puncticollis* Kraatz, 1857, largamente diffusa nella zona intertropicale. Ma l'edeago ha minore dimensione ed è dilatato, in visione ventrale (a lati paralleli in *puncticollis*). Inoltre la nuova specie presenta tre lobi mediani al margine posteriore del sesto urotergo libero del ♂, mentre *puncticollis* ne ha uno solo.

ETIMOLOGIA. Il nome della nuova specie è in riferimento ai tre lobi del margine posteriore del sesto urotergo libero del ♂.

Coenonica quadrilobata sp. n.   Figg. 67-70

Holotypus ♂, Sabah, Crocker Ra., 1600 m, Km 51 rte.Kota Kinabalu-Tambunan, 18.V.1987, Burckhardt & Löbl leg. (MHNG).

DESCRIZIONE. Lungh. 1,7 mm. Corpo lucido e giallo-rossiccio, con elitre brune con base giallo-rossiccia; antenne brune con i due antennomeri basali e l'undicesimo giallo-rossicci; zampe gialle. La punteggiatura del capo è distinta e assente sulla fronte. La granulosità del pronoto è indistinta, quella delle elitre è confusa e quella dell'addome è saliente. La reticolazione del capo è superficiale, quella del pronoto è netta e quella delle elitre e dell'addome è distinta. Edeago figg. 68-69, sesto urotergo libero del ♂ fig. 70.

COMPARAZIONI. La nuova specie è affine a *C. trilobata* sp. n. sopra descritta. Se ne distingue per il differente colore delle antenne e del corpo, per presentare quattro lobi al margine posteriore del sesto urotergo libero del ♂ e per l'edeago più profondamente ricurvo al lato ventrale.

ETIMOLOGIA. Il nome della nuova specie è in riferimento ai quattro lobi del margine posteriore del sesto urotergo libero del ♂.

Coenonica pansa sp. n.   Figg. 71-75

Holotypus ♂, Sabah, Mt. Kinabalu,1750 m, 27.IV.1987, leg. Burckhardt & Löbl (MHNG).
Paratypus: 1 ♀, stessa provenienza.

DESCRIZIONE. Lungh. 2,0 mm. Corpo lucido e giallo-rossiccio, con elitre brune con base giallo-rossiccia; antenne rossicce con i due antennomeri basali e l'undicesimo giallo-rossicci; zampe gialle. La punteggiatura del capo è fitta e netta. La granulosità del pronoto è confusa, quella delle elitre è distinta e quella dell'addome è saliente. La reticolazione del capo è assente, quella del pronoto è vigorosa e quella delle elitre è netta. Edeago figg. 72-73, sesto urotergo libero del ♂ fig. 75, spermateca fig. 74.

COMPARAZIONI. La nuova specie è affine alle due specie immediatamente precedenti: *C. trilobata* sp. n. e *C. quadrilobata* sp. n. Si distingue dalla prima per il colore differente delle antenne e del corpo e da entrambe per il lobo mediano del margine pos-
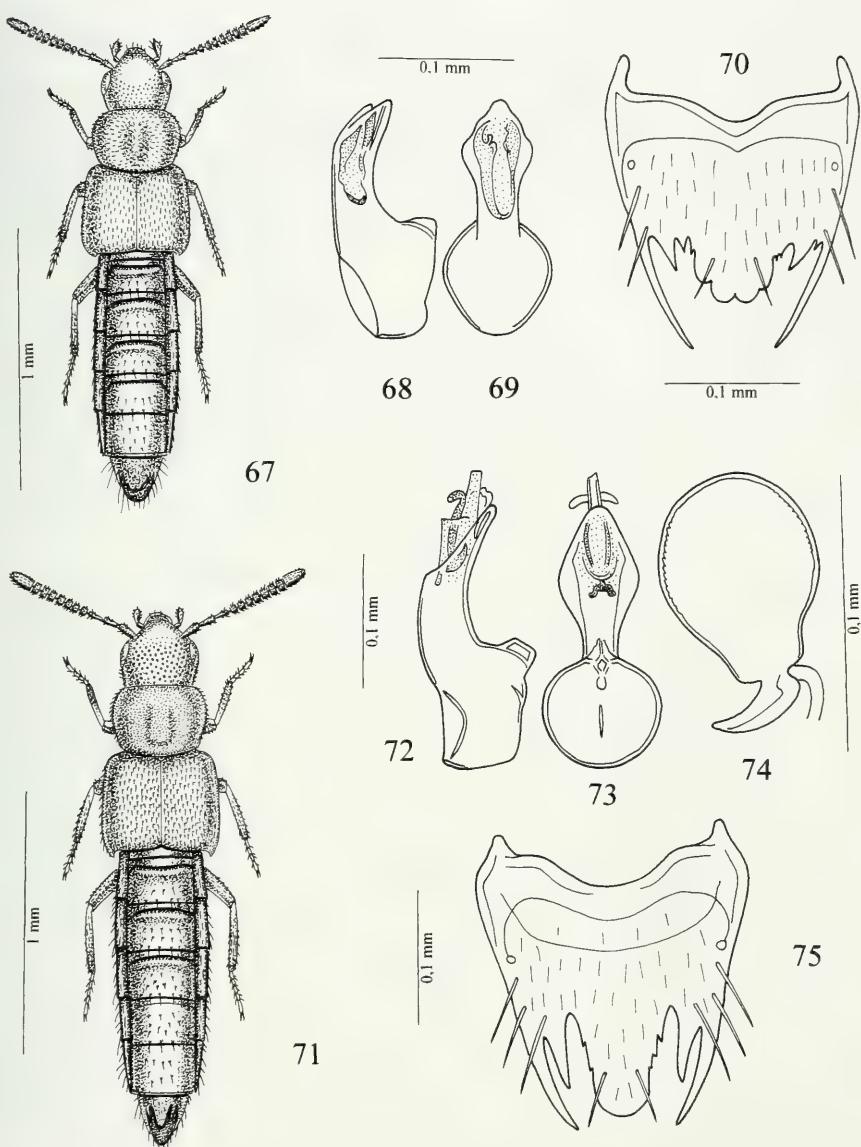
FIGG. 67-75

Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 67-70: *Coenonica quadrilobata* sp. n.; 71-75: *Coenonica pansa* sp. n.

teriore del sesto urotergo libero del ♂ che è lungo e seghettato ai lati e per l'edeago che ha maggiore sviluppo nella nuova specie, con espansioni laterali più accentuate, in visione ventrale.

ETIMOLOGIA. Il nome della nuova specie significa "espansa" e allude all'edeago dilatato nella regione preapicale, in visione ventrale.

Coenonica cryptospina sp. n.   Figg. 76-80

Holotypus ♂, Sabah, Mt. Kinabalu,1550-1650 m, 24.IV.1987, leg. Burckhardt & Löbl (MHNG).

Paratypi: 1 ♂ e 8 es., Sabah, Poring Hot Springs, 500 m, 7.V.1987, leg. Burckhardt & Löbl; 3 es., Sabah, Poring Hot Springs, 550-600 m, 9.V.1987, leg. Burckhardt & Löbl; ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 480 m, 10.V.1987, leg. Burckhardt & Löbl; 4 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, nr. Bat Cave, 600 m, 10.V.1987, Burckhardt & Löbl leg.; 1 es., Sabah, Poring Hot Springs, 500 m, 13.V.1987, leg. Burckhardt & Löbl; 1 ♀, Borneo, Sabah, Mt. Kinabalu N.P., 1750 m, 27.IV.1987, Burckhardt & Löbl leg.

DESCRIZIONE. Lungh. 2,0 mm. Capo e pronoto opachi, resto del corpo lucido. Corpo rossiccio, con capo ed elitre bruni; antenne rossicce con i due antennomeri basali e l'apice dell'undicesimo giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo e del pronoto è netta. La granulosità delle elitre è distinta e frammista a forti punti isolati. L'addome presenta granulosità saliente sui tre uroterghi basali e superficiale sui restanti. La reticolazione delle elitre è distinta, assente sul resto del corpo, tranne nel fondo dei solchi trasversi basali degli uroterghi dove è vigorosa. Alla base del pronoto stanno due impressioni mediane superficiali. Edeago figg. 77-78, sesto urotergo libero del ♂ fig. 80, spermateca fig. 79.

COMPARAZIONI. La nuova specie presenta due impressioni mediane posteriori del pronoto e un solo lobo mediano al margine posteriore del sesto urotergo libero del ♂. Per questi caratteri è possibile che la nuova specie sia tassonomicamente affine a *C. fuscipennis* (Cameron, 1920), di Singapore. Questa specie è il tipo del genere *Deralia* Cameron, 1920. L'esame dell'olotipo ♂ mi ha permesso di riconoscere che questo genere è sinonimo di *Coenonica* Kraatz, 1857, essendo i palpi labiali, ligula e altri caratteri generici non molto differenti da quelli della specie di questo genere. Pertanto *Deralia* Cameron, 1920 è nuovo sinonimo di *Coenonica* Kraatz, 1857. Di conseguenza *Deralia fuscipennis* Cameron, 1920 dovrà essere chiamata *Coenonica fuscipennis* (Cameron, 1920). A conferma di questa sinonimia e nuova combinazione, sottolineo che l'edeago di *fuscipennis* è molto simile a quello di *C. varicornis* (Kraatz, 1859) (tipi da me esaminati), descritta in origine come *Leptusa varicornis* Kraatz, 1859, già trasferita da Cameron (1939) al genere *Coenonica*.

Ritornando alla comparazione della nuova specie con *C. fuscipennis,* le due specie sono ben distinte. Il pronoto della nuova specie è appena trasverso (molto trasverso in *fuscipennis*), il lobo mediano del margine posteriore del sesto urotergo libero del ♂ è larghissimo e corto nella nuova specie (molto lungo in *fuscipennis*) e l'edeago ha sviluppo molto maggiore nella nuova specie, con armatura interna molto più forte di quella dell'edeago di *C. fuscipennis*.

ETIMOLOGIA. Il nome della nuova specie significa "spina nascosta". È quella, insieme ad altre presenti a ciascun lato del lobo mediano del margine posteriore del sesto urotergo libero del ♂, visibili solo a forte ingrandimento.

Coenonica microincisa sp. n.   Figg. 81-85

Holotypus ♂. Sabah, Mt. Kinabalu, Poring Hot Springs, 550-600 m, 9.V.1987, Burckhardt & Löbl leg. (MHNG).

Paratypi: 5 es., stessa provenienza; 1 es., Borneo, Sabah, Mt. Kinabalu N.P.,1550-1650 m, 24.IV.1987, Burckhardt & Löbl leg.; 1 es., Borneo, Sabah, Mt. Kinabalu N.P.,1750 m,
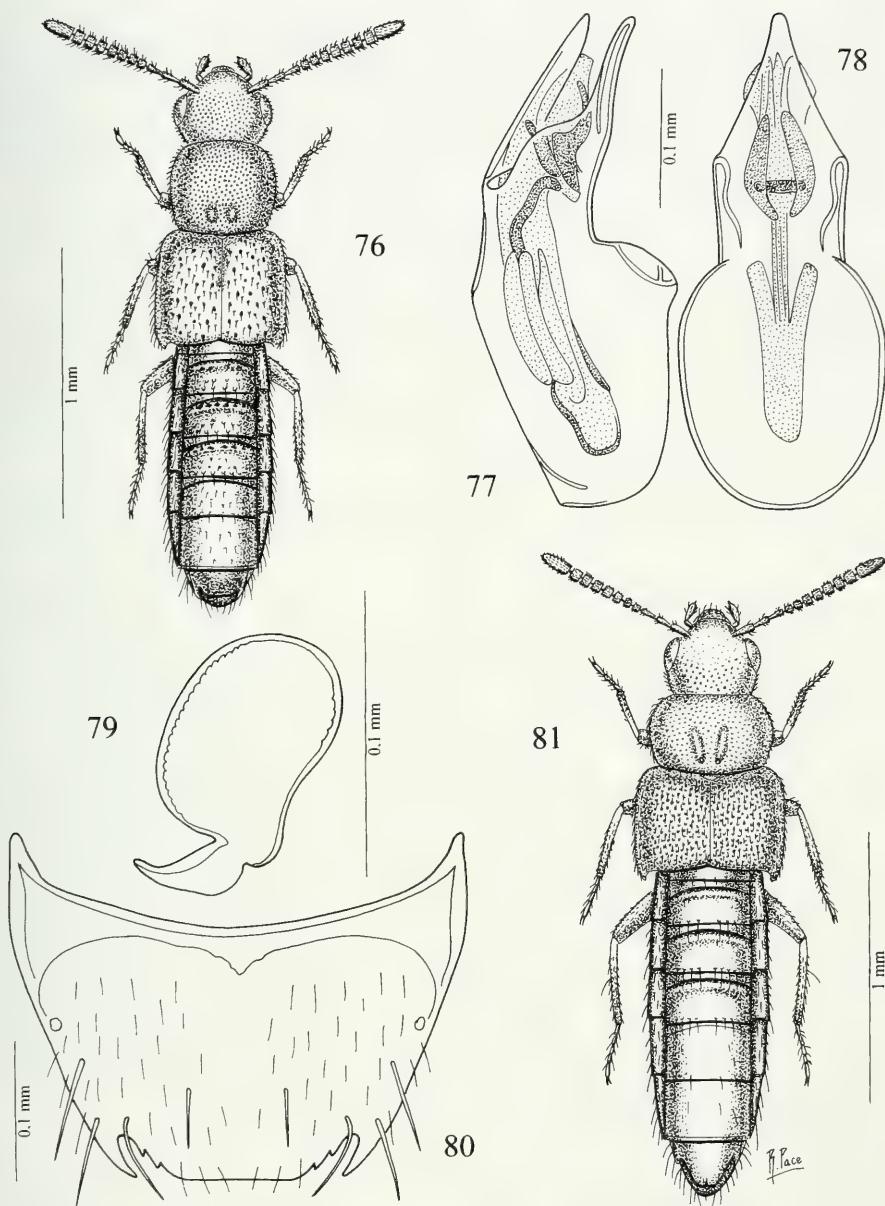
FIGG. 76-81

Habitus, edeago in visione laterale e ventrale, spermateca e sesto urotergo libero del ♂. 76-80: *Coenonica cryptospina* sp. n.; 81: *Coenonica microincisa* sp. n.

27.IV.1987, Burckhardt & Löbl leg.; 1 ♀, Borneo, Sabah, Mt. Kinabalu N.P.,1430 m, 22.V.1987, Burckhardt & Löbl leg.

DESCRIZIONE. Lungh. 2,2 mm. Corpo lucido e rossiccio, con elitre brune e addome giallo-rossiccio; antenne bruno-rossicce con i due antennomeri basali e

l'undicesimo gialli, tranne la base di quest'ultimo che è rossiccia; zampe giallo-rossicce. La punteggiatura del capo è ombelicata, superficiale e assente sulla fronte. La granulosità del pronoto è saliente, quella delle elitre è distinta e quella dell'addome è quasi indistinta. La reticolazione del capo è evidente, quella del pronoto e delle elitre è assente e quella dell'addome è distinta solo sugli uroterghi liberi quarto e quinto, sui basali è estremamente superficiale. Edeago figg. 82-83, sesto urotergo libero del ♂ fig. 85, spermateca fig. 84.

COMPARAZIONI. L'habitus e il colore del corpo e delle antenne della nuova specie sono molto simili a quelli di *C. fuscipennis* (Cameron, 1920), di Singapore. La nuova specie se ne distingue per l'assenza di quattro tubercoli sul lobo mediano del margine posteriore del sesto urotergo libero del ♂, presente in *fuscipennis,* e per avere lo stesso lobo inciso all'apice (non inciso in *fuscipennis*). L'edeago è nettamente differente nelle due specie: con bulbo basale molto sviluppato e con "crista proximalis" poco sviluppata in *fuscipennis* e con bulbo basale meno sviluppato e con "crista proximalis" molto sviluppata nella nuova specie.

ETIMOLOGIA. Il nome della nuova specie deriva dalla presenza di una piccola incisione all'apice del lobo mediano del margine posteriore del sesto urotergo libero del ♂.

Coenonica subrhomboidalis sp. n.   Figg. 86-90

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 480 m, 10.V.1987, leg. A. Smetana (MHNG).
Paratypi: 4 es., stessa provenienza; 1 ♀, Sabah, Poring Hot Springs, Langanan river, 850 m, 14.V.1987, leg. Burckhardt & Löbl.

DESCRIZIONE. Lungh. 2.1 mm. Corpo lucido e bruno-rossiccio, con elitre brune e addome giallo-rossiccio con fascia posteriore rossiccia; antenne brune con i due antennomeri basali rossicci e l'undicesimo giallo con base bruno-rossiccia; zampe gialle. La punteggiatura del capo è netta sul disco e superficiale ai lati. La granulosità del pronoto è saliente, quella delle elitre e dell'addome è distinta. Profonda è la fossetta mediana posteriore del pronoto. La reticolazione del capo è distinta, quella del pronoto è estremamente superficiale, quella delle elitre è superficiale e quella dell'addome è assente. Edeago figg. 87-88, sesto urotergo libero del ♂ fig. 90, spermateca fig. 89.

COMPARAZIONI. La nuova specie è simile a *C. varicornis* Kraatz, 1859, dello Sri Lanka, per il colore delle antenne, il pronoto trasverso e la struttura dell'edeago. Ma l'edeago della nuova specie presenta forte armatura interna (diafana in *varicornis*) e non possiede due forti tubercoli sul sesto urotergo libero del ♂.

ETIMOLOGIA. Il nome della nuova specie deriva dalla parte apicale dell'edeago a forma quasi romboidale.

Coenonica burckhardti sp. n.   Figg. 91-95

Holotypus ♂, Sabah, Poring Hot Springs, nr. Bat Cave, 600 m, 10.V.1987, leg. Burckhardt & Löbl (MHNG).
Paratypi: 1 ♂, stessa provenienza; 2 ♂♂ e 1 ♀, Sabah, Poring Hot Springs, nr. Bat Cave, 550-600 m, 9.V.1987, leg. Burckhardt & Löbl; 1 ♂, Sabah, Poring Hot Springs, Langanan Falls, 850 m, 14.V.1987, leg. Burckhardt & Löbl.

DESCRIZIONE. Lungh. 2,0 mm. Avancorpo debolmente opaco, addome lucido. Corpo rossiccio; antenne bruno-rossicce con i tre antennomeri basali giallo-rossicci e
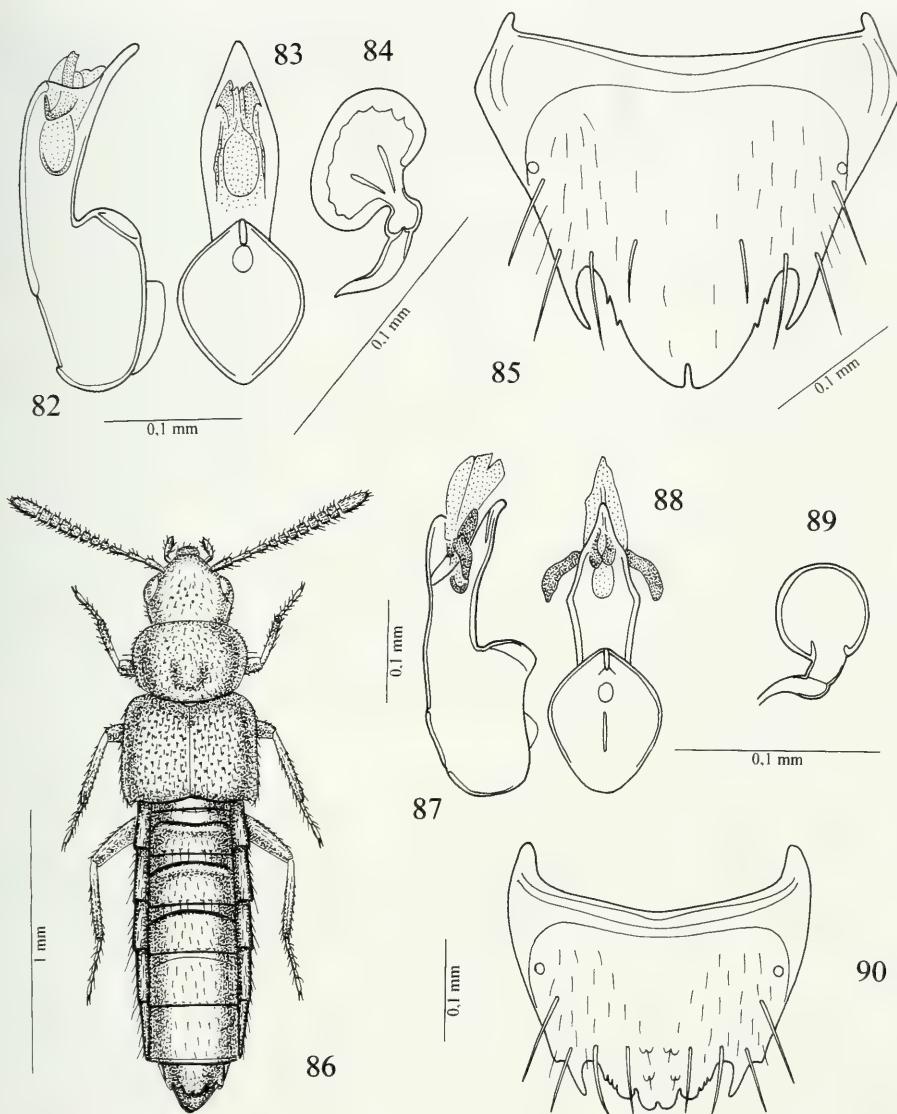
FIGG. 82-90

Edeago in visione laterale e ventrale, sesto urotergo libero del ♂, habitus e spermateca. 82-85: *Coenonica microincisa* sp. n.; 86-90: *Coenonica subrhomboidalis* sp. n.

l'undicesimo giallo con base giallo-rossiccia; zampe giallo-rossicce. La punteggiatura del capo e del pronoto è ombelicata, profonda e fittissima. I granuli che coprono le elitre sono allungati. Una reticolazione vigorosa sta sulla fronte. Assente è la reticolazione su altri parti del corpo. Edeago figg. 92-93, sesto urotergo libero del ♂ fig 95, spermateca fig. 94.

COMPARAZIONI. L'habitus della nuova specie ricorda da vicino quello di
C. fuscipennis (Cameron, 1920), di Singapore, ma l'edeago è fortemente dilatato nella
regione preapicale, in visione ventrale. Ciò non si osserva nell'edeago di *fuscipennis*.

ETIMOLOGIA. La nuova specie è dedicata a uno dei suoi raccoglitori, il dr. Daniel
Burckhardt, già del Museo di Storia Naturale di Ginevra.

Coenonica lucidula sp. n.   Figg. 96-99

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu N.P., below Layang Layang, 2600 m,
9-20.V.1987, in[terception] trap, leg. A. Smetana (MHNG).
Paratypus: 1 ♂, Borneo, Sabah, M. Kinabalu N.P., Laban Rata, 3200-3250 m, 4.V.1987,
leg. A. Smetana.

DESCRIZIONE. Lungh. 2,2 mm. Corpo lucido e bruno, con pigidio giallo-
rossiccio; antenne rossicce con i due antennomeri basali e l'apice dell'undicesimo
giallo-rossicci; zampe giallo-rossicce. La punteggiatura ombelicata del capo è superfi-
ciale. La granulosità del pronoto è quasi indistinta, quella delle elitre è distinta. La reti-
colazione del capo, del pronoto e dell'addome è netta, quella delle elitre è superficiale.
Edeago figg. 97-98, sesto urotergo libero del ♂ fig. 99.

COMPARAZIONI. L'edeago e il margine posteriore del sesto urotergo libero del ♂
ricordano da vicino quelli di *C. vulnerata* Bernhauer, 1915, del Mt. Matang (Borneo).
Ma mentre in quest'ultima specie il margine posteriore del sesto urotergo libero del ♂
è dentellato solo nella parte mediana, quello della nuova specie lo è fino alle spine lat-
erali. Inoltre, l'edeago della nuova specie è più ricurvo al lato ventrale.

ETIMOLOGIA. Il nome della nuova specie significa "un po' lucida".

Coenonica kinabaluicola sp. n.   Figg. 100-104

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu N.P., Laban Rata, 3200-3250 m, 4.V.1987,
leg. A. Smetana (MHNG).
Paratypi: 28 es., stessa provenienza; 1 ♂, Borneo, Sabah, Mt. Kinabalu N.P., Layang
Layang, 2610 m, 2.V.1987, A. Smetana leg.; 1 ♀, Sabah, Mt. Kinabalu, 2600 m, 2.V.1987, leg.
Burckhardt & Löbl; 26 es., Sabah, Mt. Kinabalu, 1750 m, 27.IV.1987, leg. Burckhardt & Löbl;
13 es., Borneo, Sabah, M. Kinabalu N.P., below Laban Rata, 3150 m, 7.VIII.1988, leg. A.
Smetana; 1 ♂, Borneo-Sabah, M. Kinabalu N.P., Summit Trail, 1890 m, (data mancante), leg. A.
Smetana.

DESCRIZIONE. Lungh. 2,7 mm. Avancorpo debolmente opaco, addome lucido.
Corpo nero pece, con pigidio rossiccio; antenne nero pece, con i due antennomeri
basali rossicci; zampe giallo-rossicce. La punteggiatura del capo è quasi indistinta,
quella del pronoto è assente. La granulosità delle elitre è fine, quella dell'addome è
distinta. La reticolazione del capo e del pronoto è vigorosa, quella delle elitre e
dell'addome è distinta. Spermateca fig. 101, edeago figg. 102-103, sesto urotergo
libero del ♂ fig. 104.

ETIMOLOGIA. Il nome della nuova specie significa "abitante del Kinabalu".

COMPARAZIONI. La nuova specie è simile a *C. soror* Cameron, 1933, pure del
Borneo, a motivo della forma simile della spermateca. Se ne distingue per i caratteri
dati nella seguente chiave.
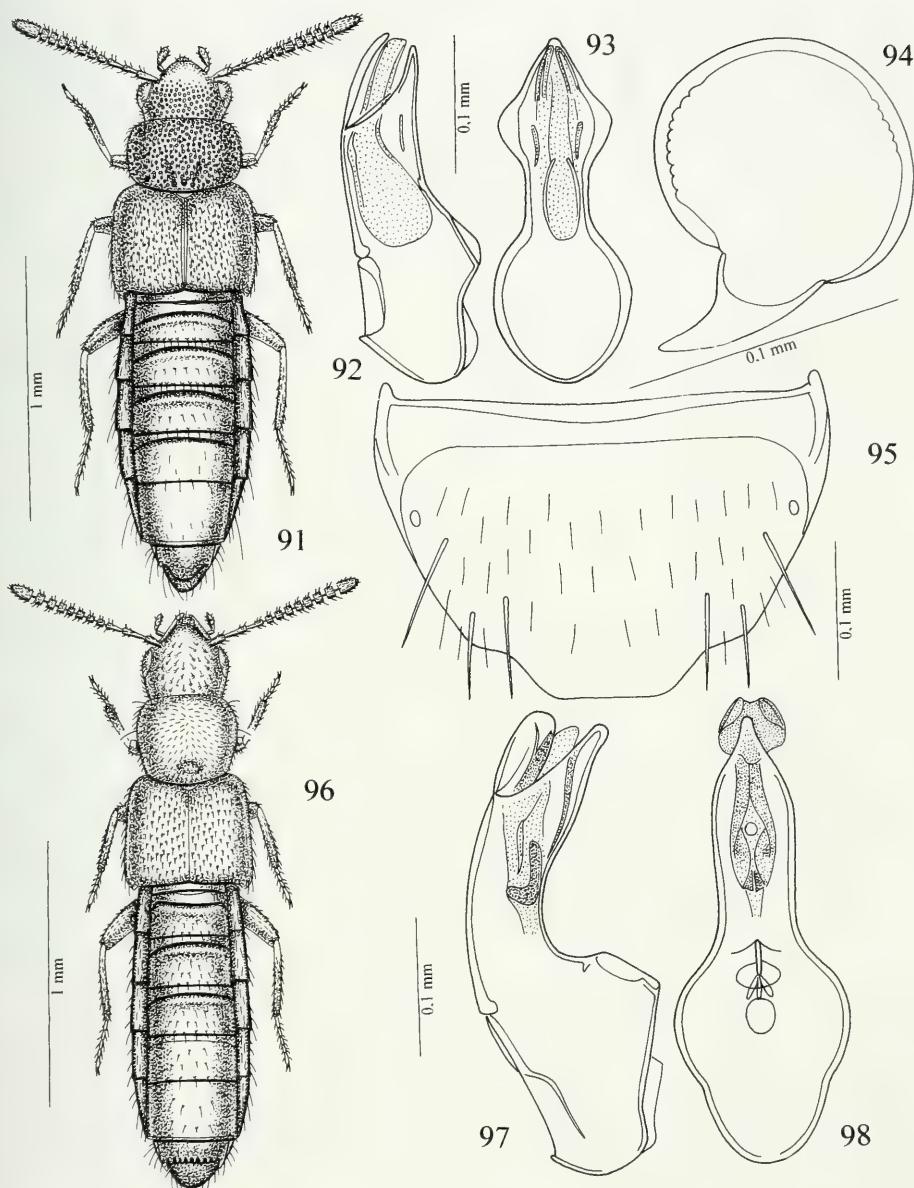
FIGG. 91-98

Habitus, edeago in visione laterale e ventrale, spermateca e sesto urotergo libero del ♂. 91-95: *Coenonica burckhardti* sp. n.; 96-98: *Coenonica lucidula* sp. n.
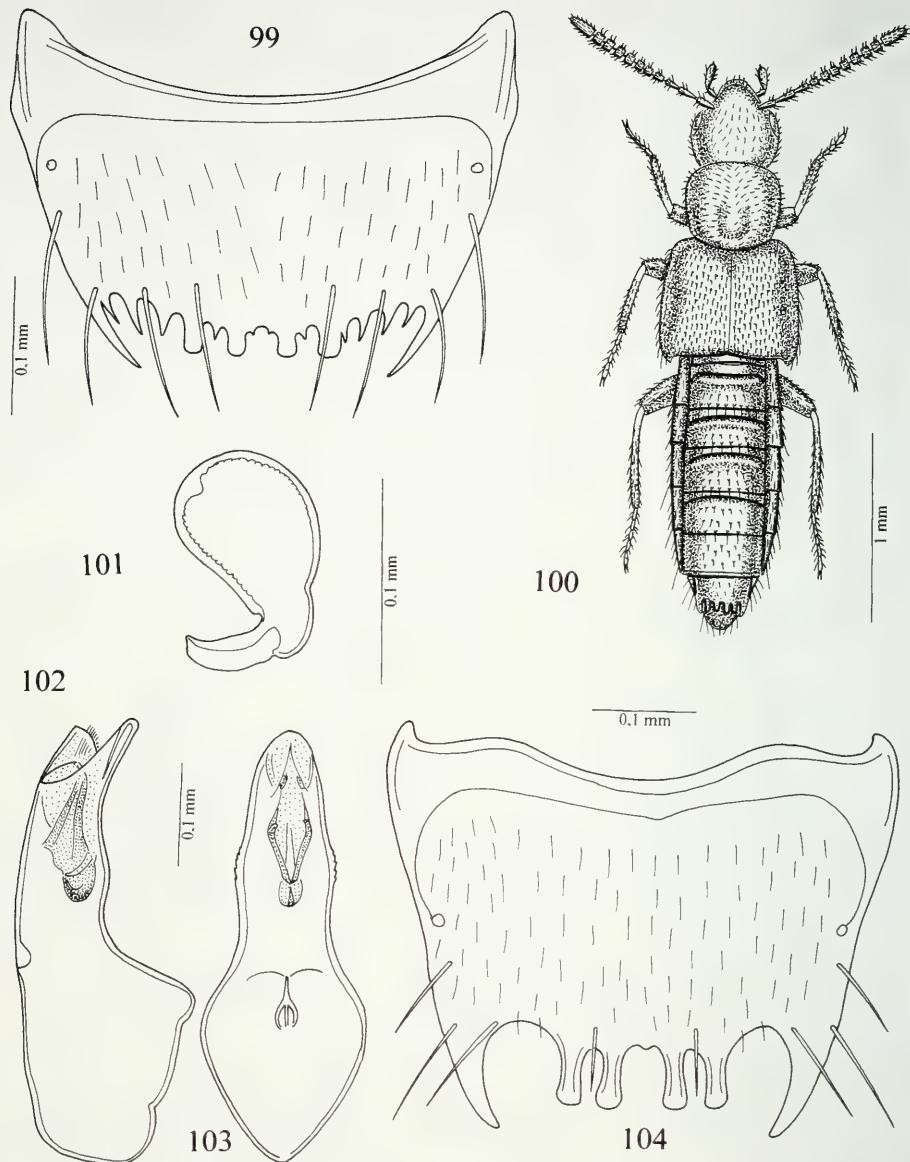
Figg. 99-104

Sesto urotergo libero del ♂, habitus, spermateca ed edeago in visione laterale e ventrale. 99: *Coenonica lucidula* sp. n.; 100-104: *Coenonica kinabaluicola* sp. n.

1   Addome giallo-rossiccio; edeago arcuato al lato ventrale; spermateca
      più sferica, senza introflessione apicale del bulbo distale; tra le spine
      laterali del margine posteriore del sesto urotergo libero del ♂ sono pre-
      senti dei dentini. Lungh. 3,0 mm. Borneo: Mt. Matang, Mt. Kinabalu
      . . . . *C. soror* Cameron
-     Addome nero pece con pigidio rossiccio; edeago sinuato al lato ventrale;
      spermateca oblunga, con introflessione apicale del bulbo distale; tra le
      spine laterali del margine posteriore del sesto urotergo libero del ♂ sono
      assenti dei dentini. Lungh. 2,7 mm. Borneo: Mt. Kinabalu
      . . . . *C. kinabaluicola* sp. n.

Coenonica bruneiensis sp. n.   Figg. 105-107

Holotypus ♂, Borneo, Brunei, HW Temburong Kuala, Belalong KBFSC, 10.II.1995,
leg. Borcherding (MRSN).

DESCRIZIONE. Lungh. 2,8 mm. Corpo lucido e nero pece, con addome nero-
bruno; antenne nere con antennomero basale nero-bruno; zampe anteriori bruno-
rossicce con femori gialli, zampe medie e posteriori nero-brune con tarsi rossicci. La
punteggiatura del capo è profonda, quella del pronoto è netta, più densa e più fine sulla
fascia longitudinale mediana e quella dell'addome profondissima, ma assente presso il
margine posteriore degli urotergo liberi primo a quarto. La granulosità delle elitre è
saliente. Ciascuna elitra del ♂ presenta una fila di tubercoli salienti presso la sutura. Il
quinto urotergo libero del ♂ mostra tubercoli allungati salienti. Edeago figg. 106-107.

COMPARAZIONI. La forma dell'edeago e l'habitus della nuova specie sono simili
a quelli di *C. angusticollis* Cameron, 1920, di Singapore (tipi da me esaminati).
L'edeago della nuova specie è strettamente arcuato al lato ventrale e la sua armatura
interna è forte e di forma complessa, mentre in *angusticollis* l'edeago è assai ampia-
mente arcuato al lato ventrale e la sua armatura interna è composta da un pezzo ricurvo
fortemente sclerificato e altri pezzi diafani. esternamente, la nuova specie ha pronoto
nettamente trasverso, mentre *angusticollis* lo ha poco.

ETIMOLOGIA. La nuova specie prende nome dal Brunei, dove è stata raccolta.

Coenonica mimoleptusa sp. n.   Figg. 108-111

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., Paka Cave, 2995 m, 5.V.1987, leg.
A. Smetana (MHNG).

DESCRIZIONE. Lungh. 2,1 mm. Corpo lucido e bruno, con addome nero e pigidio
giallo-rossiccio; antenne brune con i due antennomeri basali giallo-bruni e metà api-
cale dell'undicesimo giallo-rossiccia; zampe giallo-brune. La punteggiatura del capo è
fitta e superficiale, assente sulla fronte. La granulosità del pronoto è fitta e superficiale,
quella delle elitre è poco saliente e quella dell'addome è evidente. La reticolazione del
capo è distinta solo sulla fronte, quella del pronoto è assente, quella delle elitre è netta
e quella dell'addome è evidente. Il quinto urotergo libero del ♂ presenta tubercoli
allungati a ciascun lato della carena mediana che è poco saliente. Edeago figg.
109-110, sesto urotergo libero del ♂ fig. 111.

COMPARAZIONI. La nuova specie presenta il margine posteriore del sesto uro-
tergo libero del ♂ dentellato come quello di *C. javana* Bernhauer, 1914, di Giava,
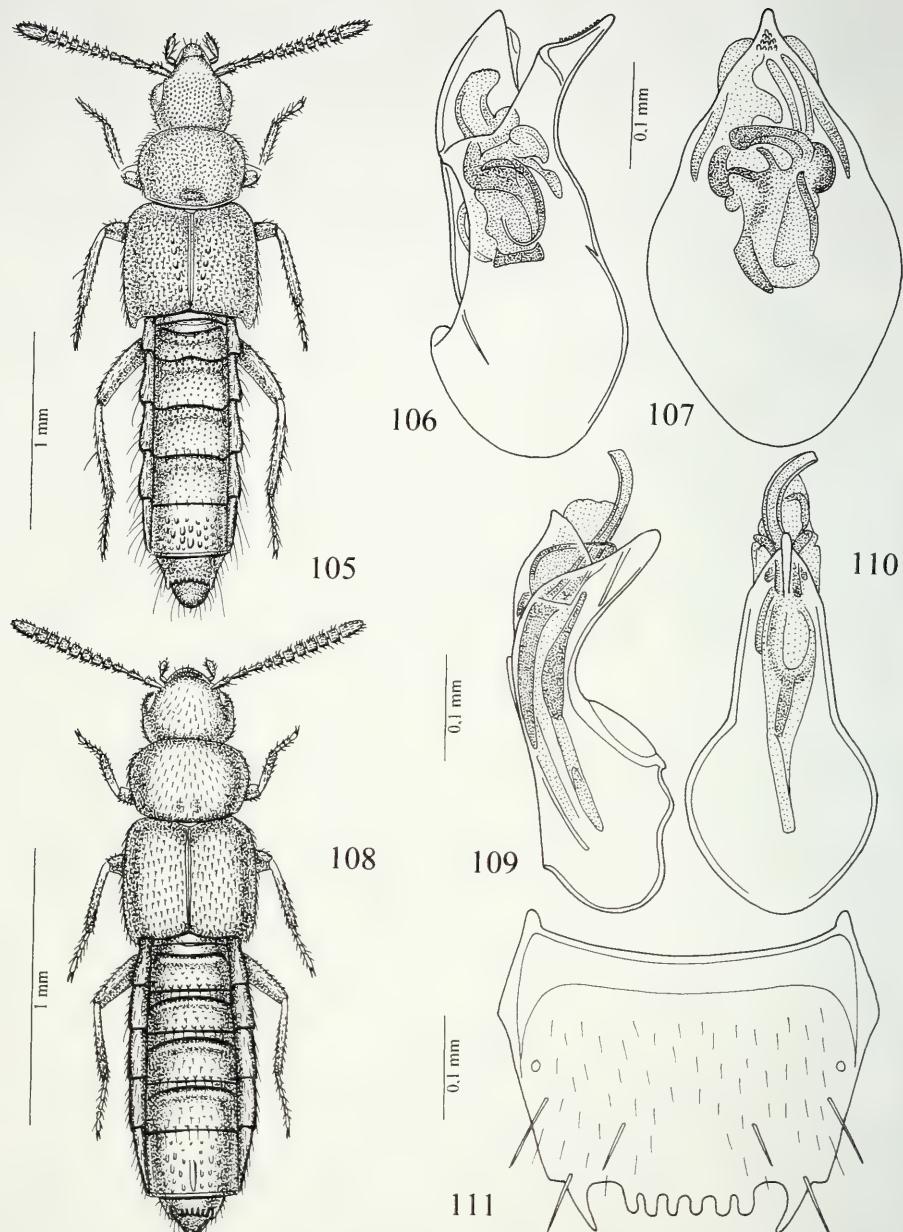
FIGG. 105-111

Habitus, edeago in visione laterale e ventrale e sesto urotergo libero del ♂. 105-107: *Coenonica bruneiensis* sp. n.; 108-111: *Coenonica mimoleptusa* sp. n.

(holotypus ♂ da me esaminato). Tuttavia, il corpo della nuova specie è superficial-
mente punteggiato o granuloso, mentre in *javana* lo è fortemente. Inoltre, l'armatura
interna dell'edeago di *javana* non è così lunga e forte come quella dell'edeago della
nuova specie.

ETIMOLOGIA. L'habitus della nuova specie ricorda da vicino delle specie del
genere *Leptusa* Kraatz, 1856. L'esame della ligula esclude l'appartenenza a questo
genere. Il suo nome significa "imitatrice di *Leptusa*".

Coenonica cristamagna sp. n.   Figg. 112-116

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat.Pk., HQ at Liwagu Rv., 1500 m,
30.IV.1987, A. Smetana leg. (MHNG).
Paratypi: 1 ♂ e 1 ♀, Borneo, Sabah, Mt. Kinabalu N.P., HQ at Liwagu Rv., 1500 m,
25.IV.1987, A. Smetana leg.

DESCRIZIONE. Lungh. 2,2 mm. Corpo lucido e bruno, con elitre nero-brune;
antenne brune con i due antennomeri basali, la base del terzo e l'apice dell'undicesimo
gialli; zampe giallo-rossicce. La punteggiatura del capo è fitta, superficiale e assente
sulla fronte. La granulosità del pronoto è distinta, quella delle elitre è forte e saliente e
quella dell'addome è molto superficiale, tranne i granuli del margine posteriore degli
uroterghi. La reticolazione della fronte e dell'addome è distinta, quella del pronoto è
ben visibile, quella delle elitre è assente. Edeago figg. 113-114, sesto urotergo libero
del ♂ fig. 115, spermateca fig. 116.

COMPARAZIONI. La nuova specie apparentemente è simile a *C. microincisa* n.
sp. sopra descritta, se si osserva la forma del margine posteriore del sesto urotergo
libero del ♂. Tuttavia, l'edeago della nuova specie non è slanciato come quello di
microincisa e il suo apice è largo (acuto in *microincisa*).

ETIMOLOGIA. Il nome della nuova specie significa "grande cresta". È quella
prossimale del suo edeago.

Coenonica leptusaesimilis sp. n.   Figg. 117-119

Holotypus ♂, Sabah, [Mt. Kinabalu N.P.], Poring Hot Springs, 550-600 m, 9.V.1987,
Burckhardt & Löbl leg. (MHNG).

DESCRIZIONE. Lungh. 2,3 mm. Corpo lucido e bruno; antenne bruno-rossicce,
con i tre antennomeri basali e l'undicesimo giallo-rossiccio; zampe bruno-rossicce. La
punteggiatura del capo e del pronoto è profonda e fitta. La granulosità delle elitre è
saliente e assente lungo il margine posteriore delle stesse elitre. Gli uroterghi sono
coperti di granulosità evidente. La reticolazione è netta solo sulla fronte e sul pronoto.
Assente è sul resto del corpo. Edeago figg. 117-118.

COMPARAZIONI. L'habitus della nuova specie è simile a quello di *C. rufiventris*
Cameron, 1943, pure del Borneo (holotypus ♀ da me esaminato). Tuttavia, la nuova
specie non ha il capo e il pronoto coperti di granulosità forte come in *rufiventris*.

ETIMOLOGIA. L'habitus della nuova specie è simile quello di alcune specie del
genere *Leptusa* Kraatz, 1856. Ma l'esame della ligula esclude questa attribuzione
generica. Pertanto la nuova specie è chiamata "simile a *Leptusa*".
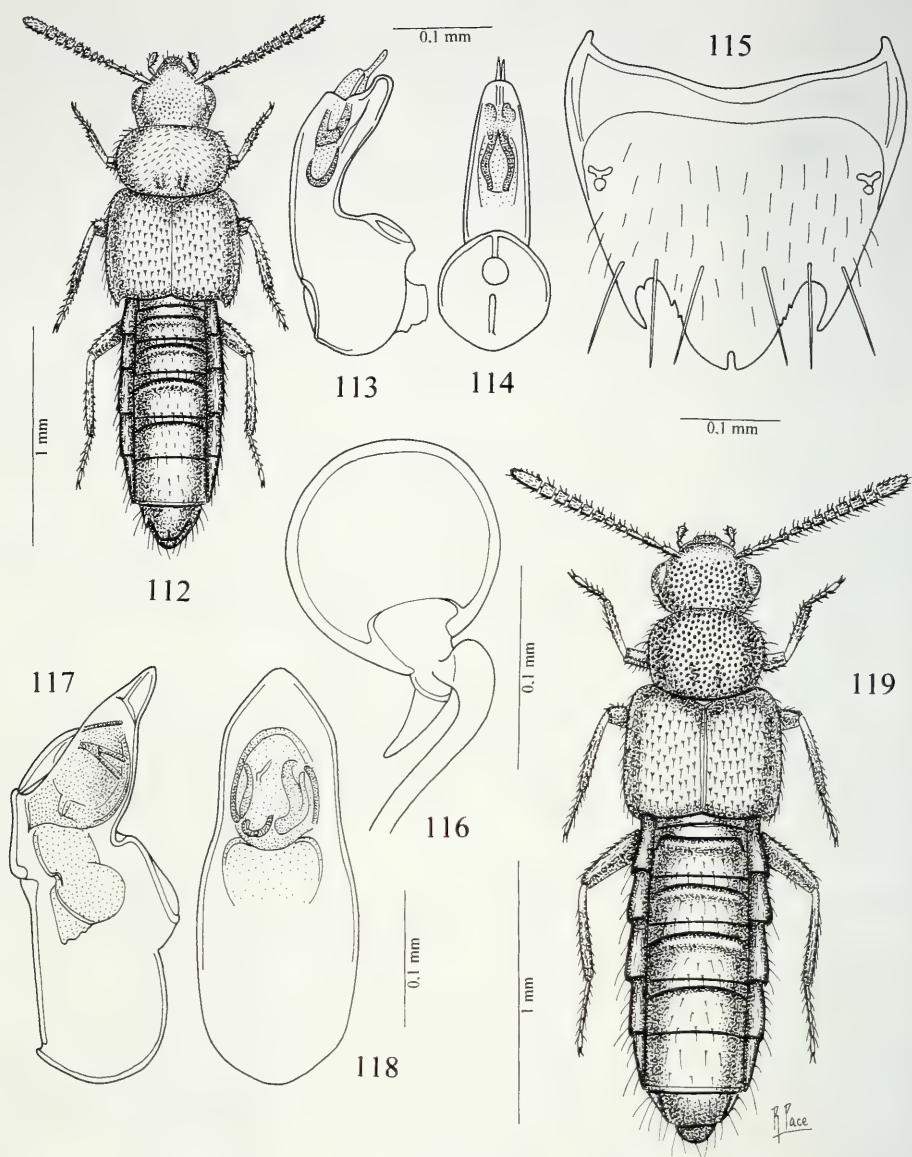
FIGG. 112-119

Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 112-116: *Coenonica cristamagna* sp. n.; 117-119: *Coenonica leptusaesimilis* sp. n.

Coenonica muluensis sp. n.   Figg. 120-124

Holotypus ♂, Borneo, Sarawak, Mulu Nat. Park, leg. H. Franz, (NHMW).
Paratypi: 2 ♀ ♀, stessa provenienza.

DESCRIZIONE. Lungh. 2,5 mm. Avancorpo debolmente lucido, addome lucido. Corpo giallo-rossiccio, con elitre brune, tranne la base e i lati che sono rossicci, quarto

urite libero bruno-rossiccio; antenne bruno-rossicce con i due antennomeri basali rossicci e l'undicesimo giallo-rossiccio; zampe gialle. La punteggiatura del capo e del pronoto è fitta e profonda. La granulosità delle elitre è fittissima e saliente, quella dei due uroterghi basali è distinta e quella dei restanti uroterghi è assai rada. Il terzo urotergo libero del ♂ presenta una bozza mediana saliente. Edeago figg. 121-122, sesto urotergo libero del ♂ fig. 124, spermateca fig. 123.

COMPARAZIONI. La nuova specie , per la presenza di una bozza mediana sul terzo urotergo libero del ♂, per la distribuzione della punteggiatura dell'avancorpo, per il margine posteriore del sesto urotergo libero del ♂, è sicuramente affine a *C. angusticollis* Cameron, 1943, di Singapore (tipi da me esaminati). Tuttavia, per la forma dell'edeago, è chiaramente distinta. L'armatura interna dell'edeago è corta e larga nella nuova specie e lunga e sottile in *angusticollis*.

ETIMOLOGIA. La nuova specie prende nome dalla sua località tipica Mulu.

Coenonica rhomboidalis sp. n.   Figg. 125-129

Holotypus ♂, Borneo-Sabah, Mt. Kinabalu Nat. Pk., HQ 1560-1660 m, 24.IV.1987, leg. A. Smetana, (MHNG).

Paratypi: 4 es., stessa provenienza; 4 es., Sabah, Mt. Kinabalu, 1580 m, 27.IV.1987, leg. Burckhardt & Löbl; 2 es., Sabah, Poring Hot Springs, 550-600 m, 9.V.1987, leg. Burckhardt & Löbl;1 es., Borneo-Sabah, Crocker Ra., 1550-1650 m, 16.V.1987, leg. Burckhardt & Löbl; 1 ♂, Borneo-Sabah, Mt. Kinabalu Nat. Pk., HQ Silau-Silau Tr., 1560 m, 3.VIII.1988, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,6 mm. Corpo lucido e bruno-rossiccio, con addome rossiccio che ha una fascia posteriore bruno-rossiccia; antenne brune con i due antennomeri basali, la base del terzo e apice dell'undicesimo giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo e fittissima e profonda. La granulosità del pronoto e delle elitre è molto saliente, quella dell'addome è fine. Edeago figg. 126-127, sesto urotergo libero del ♂ fig. 129, spermateca fig 128.

COMPARAZIONI. La nuova specie presenta il lobo mediano del margine posteriore del sesto urotergo libero del ♂ inciso all'apice, come in *C. microincisa* e *C. cristamagna* nuove specie sopra descritte. Se ne distingue chiaramente per i lati dell'edeago espansi, in visione ventrale. I lati dell'edeago delle due specie a comparazione non lo sono.

ETIMOLOGIA. La nuova specie prende nome dalla forma quasi romboidale della parte apicale dell'edeago, in visione ventrale.

Coenonica magnilobata sp. n.   Figg. 130-133

Holotypus ♂, Sabah, E Mt. Kinabalu, 1150 m, rte. Ranau-Kota Kinabalu, 24.V.1987, leg. Burckhardt & Löbl (MHNG).

DESCRIZIONE. Lungh. 2,5 mm. Corpo lucido e rossiccio, con elitre brune; antenne bruno-rossicce con i due antennomeri basali, la base del terzo e l'undicesimo giallo-rossicci; antenne giallo-rossicce. La punteggiatura del capo è distinta solo sul disco, ai lati è confusa. La granulosità del pronoto è saliente, quella delle elitre è grossolana e fittissima. Gli uroterghi sono coperti da carene longitudinali salienti, tranne il quinto libero. Edeago figg. 131-132, sesto urotergo libero del ♂ fig. 133.

COMPARAZIONI. Per la presenza di un grande lobo mediano del margine posteriore del sesto urotergo libero del ♂ e per l'edeago molto arcuato al lato ventrale,
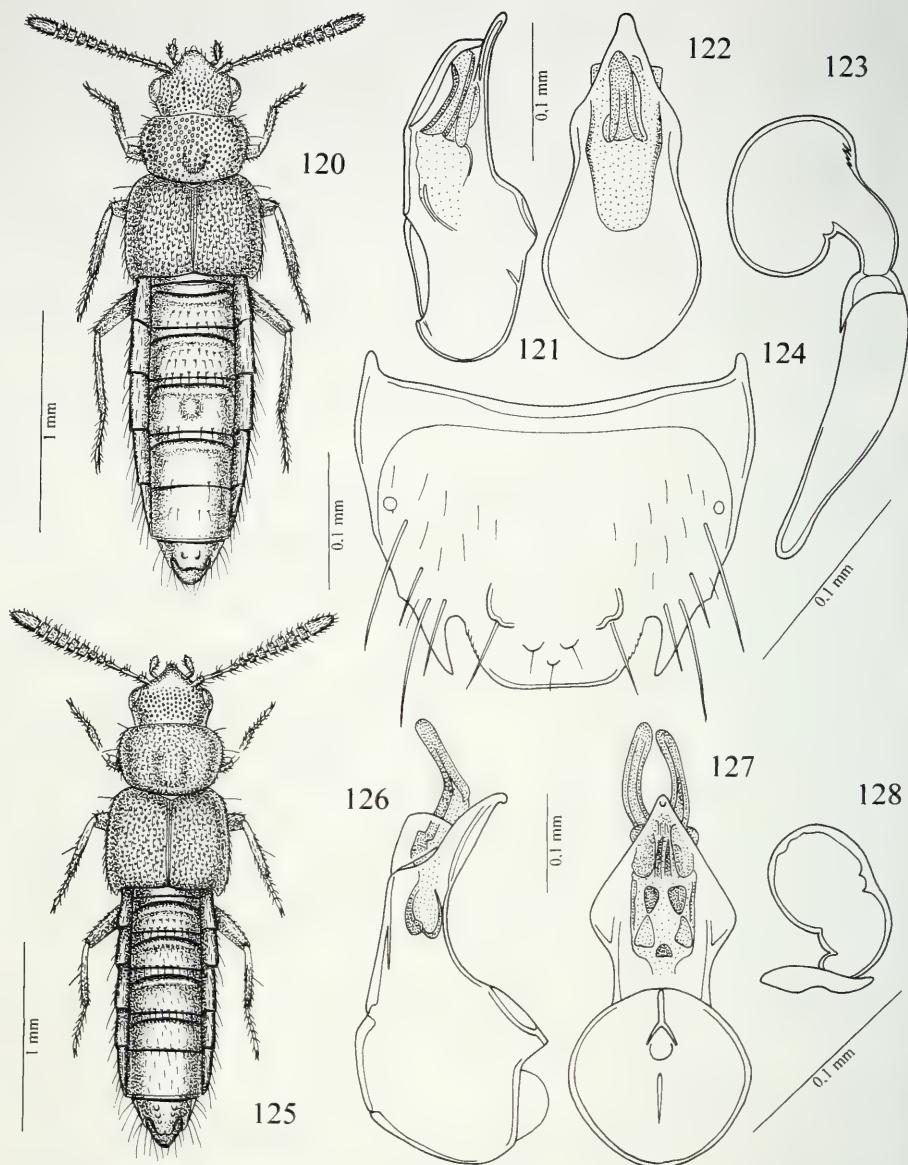
FIGG. 120-128

Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 120-124: *Coenonica muluensis* sp. n.; 125-128: *Coenonica rhomboidalis* sp. n.

la nuova specie è forse affine a *C. malayana* Cameron, 1936, di Malaya (holotypus ♂ da me esaminato). Se ne distingue per la presenza di carene longitudinali degli uroterghi liberi primo a quarto e per l'edeago espanso nella regione preapicale, in visione ventrale (a lati quasi paralleli in *malayana*).
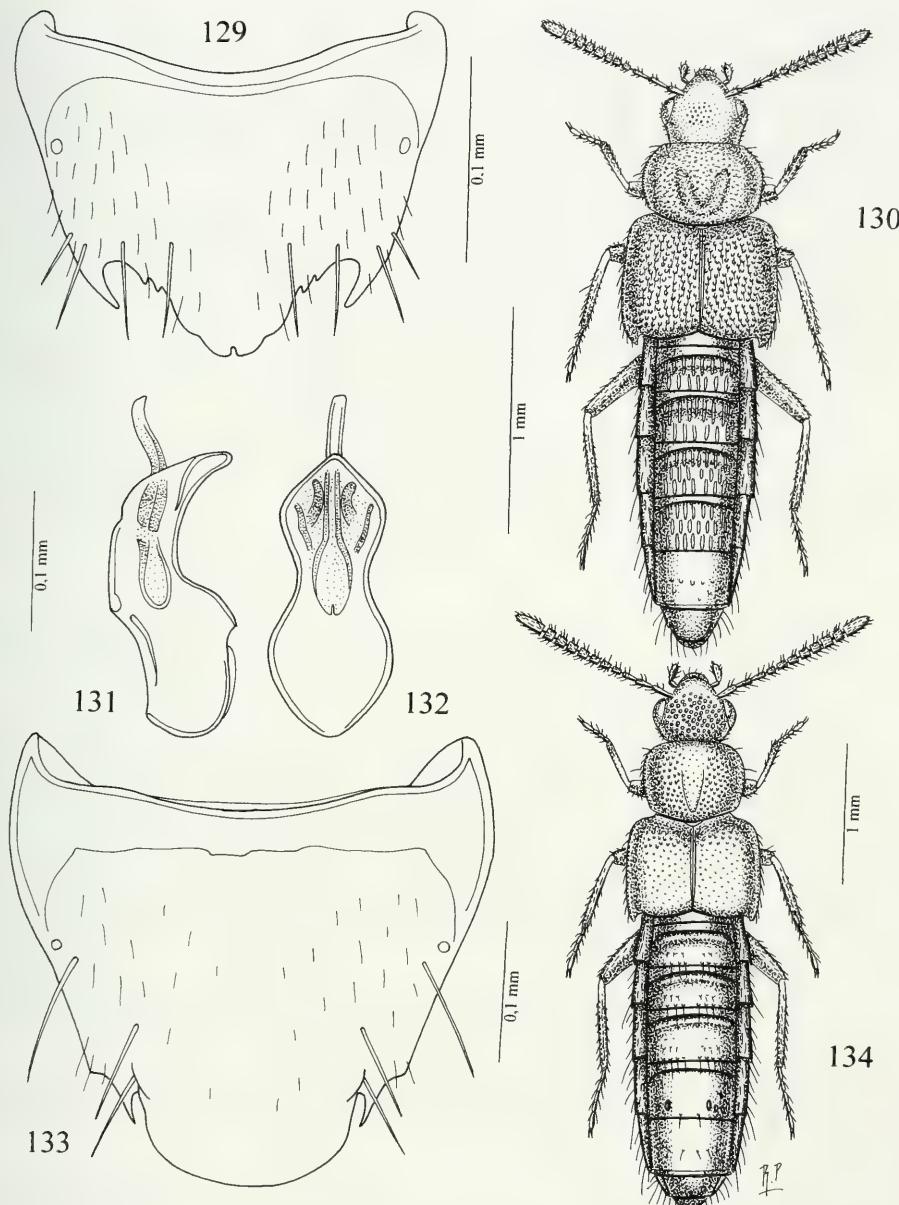
Figg. 129-134

Sesto urotergo libero del ♂, habitus ed edeago in visione laterale e ventrale. 129: *Coenonica rhomboidalis* sp. n.; 130-133: *Coenonica magnilobata* sp. n.; 134: *Coenonica obscuripalpi* sp. n.

Etimologia. Per la presenza di un grande lobo mediano al margine posteriore del sesto urotergo libero del ♂, la nuova specie è chiamata "dotata di un grande lobo".

Coenonica obscuripalpi sp. n.   Figg. 134-137

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1500 m, 25.IV.1987, leg. A. Smetana (MHNG).

Paratypi: 5 es., stessa provenienza; 12 es., Borneo, Sabah, Mt. Kinabalu N.P., 1750 m, 21.IV.1987, Burckhardt & Löbl leg.; 5 es., Borneo, Sabah, Mt. Kinabalu N.P., 1580 m, 21.IV.1987, Burckhardt & Löbl leg.; 3 ♀♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1500 m, 1.IX.1988, leg. A. Smetana.

DESCRIZIONE. 3,8 mm. Corpo lucido e bruno-rossiccio, con margine posteriore dei tre uriti basali rossicci; antenne bruno-rossicce con i tre antennomeri basali giallo-rossicci e l'undicesimo giallo; zampe bruno-rossicce con tarsi giallo-rossicci. La punteggiatura del capo è ombelicata e grossolana. La granulosità del pronoto e delle elitre è saliente, più grossolana alla base delle elitre. Il quarto urotergo libero presenta a ciascun lato due-tre fossette. Assente è la reticolazione del corpo. Edeago figg. 135-136, spermateca fig. 137.

COMPARAZIONI. L'habitus della nuova specie è simile a quello di *C. philippina* Bernhauer, 1916, delle Filippine (tipi da me esaminati). Tuttavia, l'edeago della nuova specie ha apice molto protratto (cortissimo in *philippina*).

ETIMOLOGIA. La nuova specie prende nome dal colore oscuro dei suoi palpi mascellari.

Coenonica pallipes sp. n.   Figg.138-141

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ 1560-1600 m, 24.IV.1987, A. Smetana leg.(MHNG).

Paratypi: 2 ♂♂, stessa provenienza.

DESCRIZIONE. Lungh. 2,8 mm. Corpo lucido e nero-bruno; antenne nero-brune con i tre antennomeri basali giallo-rossicci; zampe brune con tarsi e tibie anteriori gialli. La punteggiatura del capo è composta da punti ombelicati enormi e grossolani. La granulosità del pronoto è grossolana ed è assente nei pressi del margine posteriore, quella delle elitre è composta di granuli allungati e netti. Gli uroterghi sono pressoché nudi, con qualche sparsa setola. Il quinto urotergo libero del ♂ ha una carena mediana concava. Assente è la reticolazione sul corpo. Edeago figg. 139-140, sesto urotergo libero del ♂ fig. 141.

COMPARAZIONI. L'habitus della nuova specie è simile a quello di *C. philippina* Bernhauer, 1916, delle Filippine (tipi da me esaminati). Tuttavia, l'edeago della nuova specie è slanciato e non tozzo come quello di *philippina*.

ETIMOLOGIA. La nuova specie, avendo i tarsi gialli e meso-metatibie brune, è chiamata "dai piedi pallidi".

Coenonica spinae sp. n.   Figg. 142-146

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat. Pk., HQ at Liwagu Rv., 1500 m, 16.V.1987, leg. A. Smetana (MHNG).

Paratypi: 7 es., Borneo, Sabah, Mt. Kinabalu, 1750 m, 21.IV.1987, Burckhardt & Löbl leg.; 1 ♀, Borneo, Sabah, Mt. Kinabalu Nat. Pk., Poring Hot Springs, 510 m, 12.V.1987, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,6 mm. Corpo lucido e nero-bruno; antenne nero-brune con i due antennomeri basali rossicci; zampe nero-brune con i tarsi bruno-rossicci. La
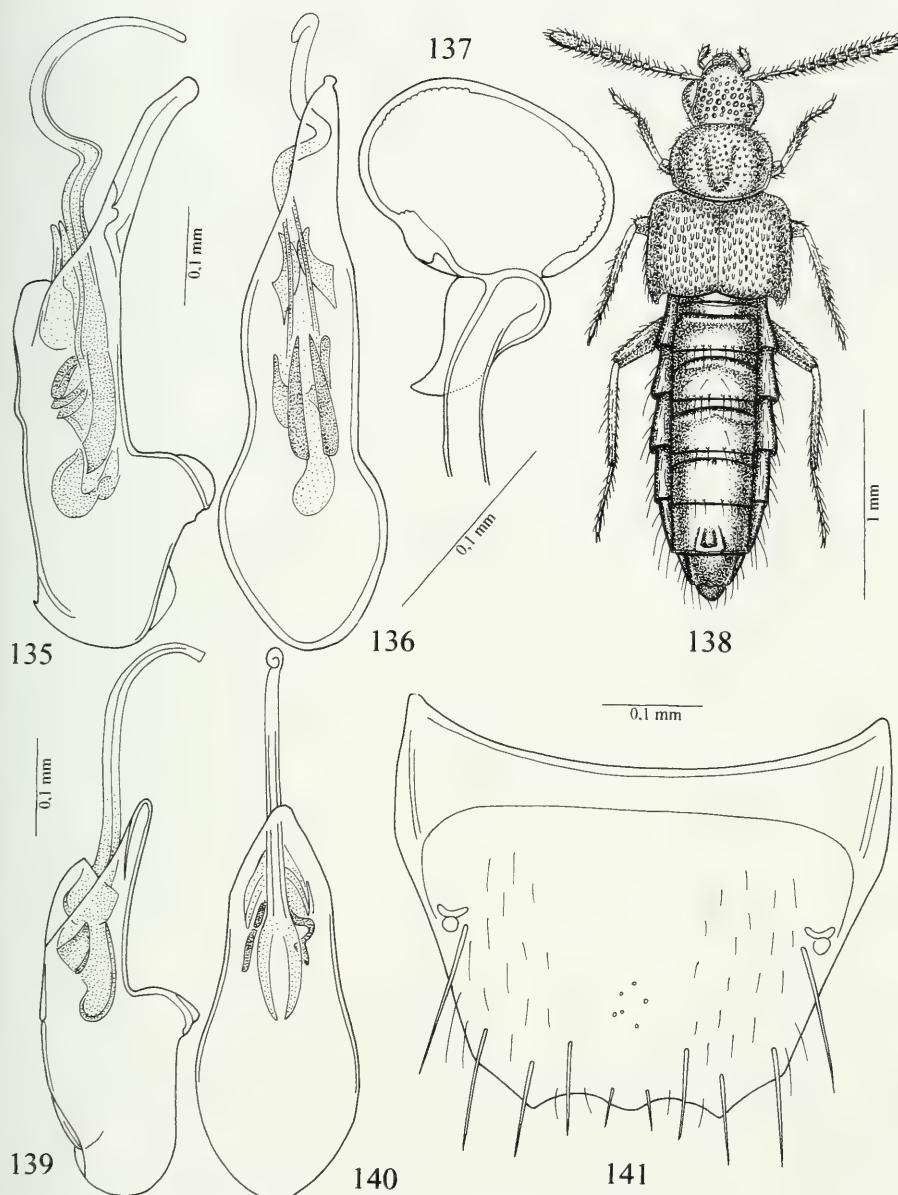
FIGG. 135-141

Edeago in visione laterale e ventrale, spermateca, habitus e sesto urotergo libero del ♂. 135-137: *Coenonica obscuripalpi* sp. n.; 138-141: *Coenonica pallipes* sp. n.
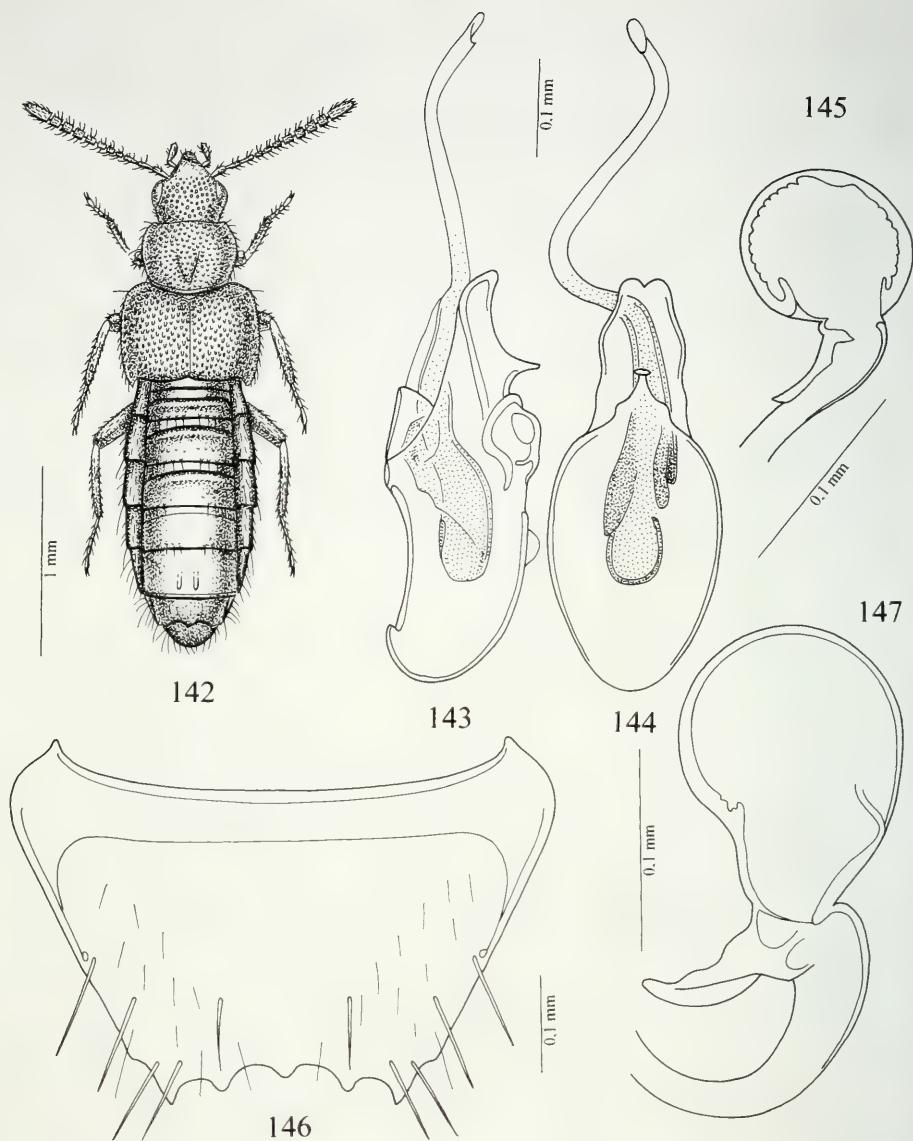
FIGG. 142-147

Habitus, edeago in visione laterale e ventrale, spermateca e sesto urotergo libero del ♂. 142-146: *Coenonica spinae* sp. n.; 147: *Coenonica troglobia* sp. n.

punteggiatura del capo è ombelicata e profondissima. La granulosità del pronoto è grossolana, quella delle elitre è composta di granuli appena allungati e forti. L'addome è coperto di granulosità saliente distribuita come da fig. 142. Assente è la reticolazione del corpo. Edeago figg. 143-144, sesto urotergo libero del ♂, fig. 146, spermateca fig. 145.

COMPARAZIONI. L'edeago della nuova specie è simile a quello di *C. philippina* Bernhauer, 1916, delle Filippine (tipi da me esaminati). Anche per i caratteri dell'habitus l'affinità tassonomica delle due specie è sicura. La nuova specie si differenzia da essa per avere il tubulo sporgente dell'edeago nettamente più lungo di quello di *philippina* e l'apice dello stesso organo della nuova specie è inciso, in visione ventrale, e intero in *philippina*. Inoltre, le zampe della nuova specie sono nero-brune e in *philippina* giallo-rossicce.

Nel Borneo è nota un'altra specie di questo gruppo di *C. philippina*. È *C. ashei* Pace, 1987, che per il colore del corpo è più simile a *philippina,* ma il suo edeago è nettamente differente, avendo l'apice a paletta, in visione laterale.

ETIMOLOGIA. La nuova specie prende nome dal rilievo a forma di spina presente al lato ventrale dell'edeago.

Coenonica troglobia sp. n.   Figg. 147-150

Holotypus ♂, Sabah, Mt. Kinabalu Nat. Pk., Paka Cave, 2997 m, 5.V.1987, leg. A. Smetana (MHNG).
Paratypi: 7 es., stessa provenienza; 3 es., Sabah, Mt. Kinabalu Nat. Pk., Paka Cave, 2995 m, 2.V.1987, leg. A. Smetana; 11 es., Sabah, Mt. Kinabalu Nat. Pk., Paka Cave, 2995 m, 6.V.1987, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,9 mm. Corpo lucido e bruno-rossiccio, con addome bruno; antenne brune con i quattro antennomeri basali e l'apice dell'undicesimo giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo e del pronoto è distinta e poco profonda, quella delle elitre è netta. La granulosità dell'addome è distinta. La reticolazione del capo, del pronoto e dell'addome è distinta, quella delle elitre è superficiale. Edeago figg. 149-150, spermateca fig. 147.

COMPARAZIONI. Un edeago di enormi dimensioni e dentato alla regione preapicale ventrale non è mai stato osservato nel genere *Coenonica*, tranne nella specie seguente, che le è affine.

ETIMOLOGIA. Poiché la nuova specie è stata raccolta in una grotta, prende il nome di "cavernicola".

Coenonica perpunctata sp. n.   Figg. 151-154

Holotypus ♂, Borneo-Sabah, Mt. Kinabalu N. P., Silau-Silau Trail, 1558 m, 2.IX.1988, leg. D.E. Bright (MHNG).
Paratypi: 23 es., Sabah, Mt. Kinabalu, 1450-1550 m, 23.IV-21.V.1987, leg. Burckhardt & Löbl; 2 es., Borneo, Sabah, Mt. Kinabalu N.P., 1900 m, 26.IV.1987, Burckhardt & Löbl leg.;12 es., Sabah, Mt. Kinabalu, 1550 m, 28.IV.1987, leg. Burckhardt & Löbl; 1 es., Borneo-Sabah, Mt. Kinabalu Nat. Pk., HQ Silau-Silau Tr., 1560 m, 30.IV.1987, leg. A. Smetana; 1 es., Borneo, Sabah, Mt. Kinabalu N.P., Poring Hot Springs, nr. Bat Cave, 600 m, 10.V.1987, Burckhardt & Löbl leg.

DESCRIZIONE. Lungh. 2,8 mm. Corpo lucido e rossiccio; antenne rossicce con i tre antennomeri basali e i due terzi apicali dell'undicesimo giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo e del pronoto è profonda e fittissima. La granulosità delle elitre è grossolana, quella dell'addome è saliente. Solo gli uroterghi quarto e quinto presentano una reticolazione, che è distinta. Edeago figg. 153-154, spermateca figg. 152.
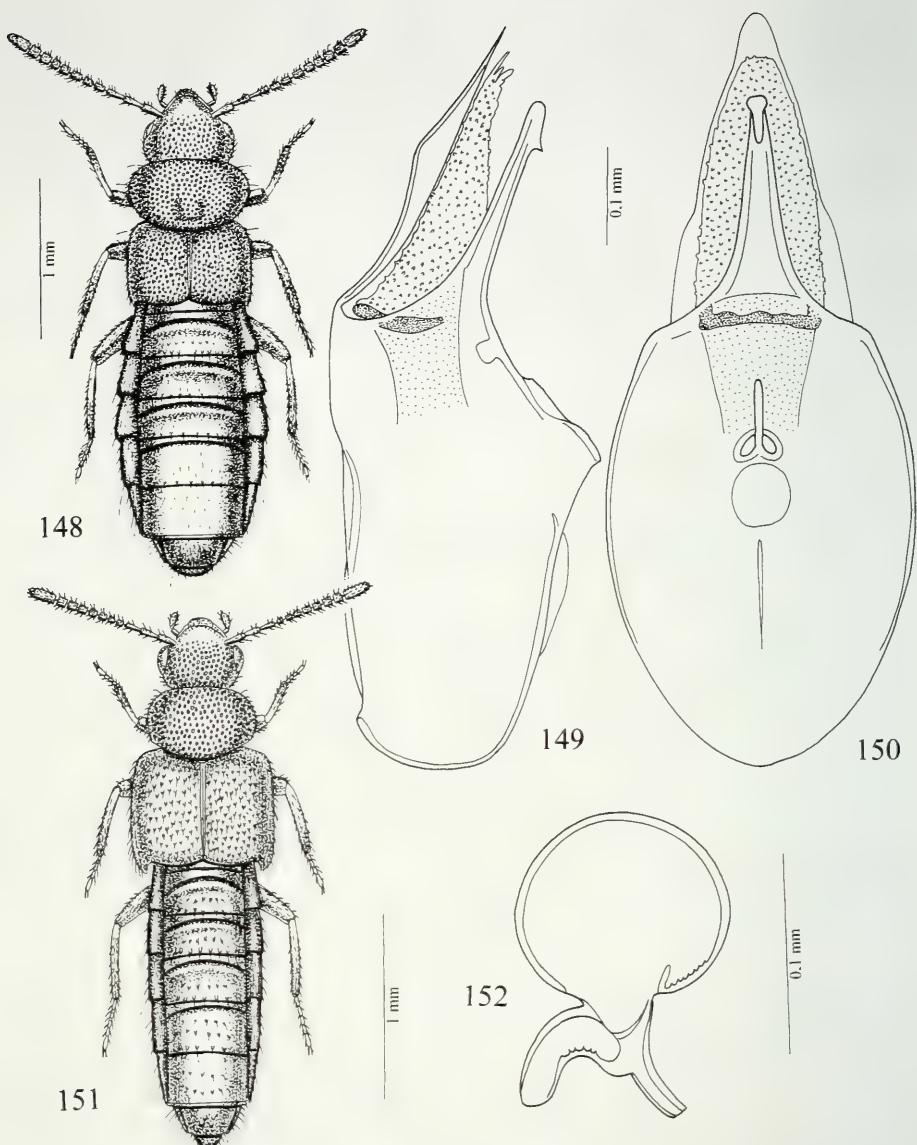
FIGG. 148-152

Habitus, edeago in visione laterale e ventrale e spermateca. 148-150: *Coenonica troglobia* sp. n.; 151-152: *Coenonica perpunctata* sp. n.

COMPARAZIONI. La nuova specie è sicuramente affine a *C. troglobia* sp. n. sopra descritta, a motivo della forma dell'edeago e per il simile habitus. Se ne distingue per l'edeago piegato ventralmente ad angolo retto, in visione laterale, (edeago largamente arcuato ventralmente in *troglobia*), per il dente preapicale ventrale dello stesso organo

nettamente più vicino all'apice di quello di *troglobia* e per la differente armatura interna dell'edeago.

Eᴛɪᴍᴏʟᴏɢɪᴀ. L'avancorpo della nuova specie è coperto da forte punteggiatura o granulosità, pertanto porta il nome di "oltremodo punteggiata".

Cʜɪᴀᴠᴇ ᴅᴇɪ ♂ ♂ ᴅᴇʟʟᴇ Sᴘᴇᴄɪᴇ ᴅᴇʟ Bᴏʀɴᴇᴏ ᴅᴇʟ Gᴇɴᴇʀᴇ *Cᴏᴇɴᴏɴɪᴄᴀ*

1	Quarto antennomero lungo quanto largo o più lungo che largo	2
-	Quarto antennomero trasverso	15
2	Quarto antennomero più lungo che largo	3
-	Quarto antennomero lungo quanto largo	9
3	Capo, pronoto ed elitre superficialmente punteggiati o finemente granulosi. Lungh. 2,7 mm. Borneo: Mt. Kinabalu . . . . *C. kinabaluicola* sp. n.	
-	Capo, pronoto ed elitre fortemente punteggiati o grossolanamente granulosi	4
4	Pronoto debolmente trasverso, con rapporto larghezza/lunghezza pari a 1,25; quarto urotergo libero con fossette laterali; edeago molto prolungato all'apice. Lungh. 3,8 mm. Borneo: Mt. Kinabalu . . *C. obscuripalpi* sp. n.	
-	Pronoto nettamente trasverso, con rapporto larghezza/lunghezza pari a 1,31-1,71; quarto urotergo libero senza fossette laterali; edeago non prolungato all'apice	5
5	Margine posteriore del sesto urotergo libero del ♂ con un largo lobo mediano tra le spine laterali	6
-	Margine posteriore del sesto urotergo libero del ♂ rettilineo	7
6	Corpo unicolore rossiccio; terzo urotergo libero del ♂ senza bozza mediana; lati del lobo del margine posteriore del sesto urotergo libero del ♂ semplici; edeago fortemente dilatato nella regione preapicale, in visione ventrale. Lungh. 2,0 mm. Borneo: Mt. Kinabalu . *C. burckhardti* sp. n.	
-	Corpo bicolore giallo-rossiccio, con elitre e fascia addominale posteriore bruna o bruno-rossiccia; terzo urotergo libero del ♂ con una bozza mediana; lati del lobo del margine posteriore del sesto urotergo libero del ♂ seghettati; edeago appena dilatato nella regione preapicale, in visione ventrale. Lungh. 2,0 mm. Borneo: Mt. Mulu . . . *C. muluensis* sp. n.	
7	Pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,31; granulosità delle elitre mancante lungo il margine posteriore; apice dell'edeago larghissimo, in visione ventrale. Lungh. 2,3 mm. Borneo: Mt. Kinabalu . . . . *C. leptusaesimilis* sp. n.	
-	Pronoto fortemente trasverso, con rapporto larghezza/lunghezza pari a 1,55-1,71; granulosità delle elitre estesa su tutta la loro superficie; apice dell'edeago strettissimo, in visione ventrale	8
8	Corpo unicolore rossiccio; pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,55 e senza impressione mediana posteriore; edeago piegato ad angolo retto al lato ventrale. Lungh. 2,8 mm. Borneo: Mt. Kinabalu . . . . *C. perpunctata* sp. n.	
-	Corpo bicolore: avancorpo bruno-rossiccio, addome bruno; pronoto fortemente trasverso, con rapporto larghezza/lunghezza pari a 1,71 e con	

impressione mediana posteriore; edeago arcuato al lato ventrale. Lungh.
2,9 mm. Borneo: Mt. Kinabalu . . . . *C. troglobia* sp. n.

9   Uriti liberi primo a quarto coperti di carene longitudinali salienti. Lungh.
2,5 mm. Borneo . . . . *C. magnilobata* sp. n.

-     Uriti con la consueta granulosità o punteggiatura 10

10   Margine posteriore del sesto urotergo libero del ♂ con spinule solo nel
terzo mediano. Lungh. 1,7. Borneo: Mt. Matang . . . . . *C vulnerata* Bernhauer

-     Margine posteriore del sesto urotergo libero del ♂ dentellato o lobato
fino ai lati 11

11   Solco mediano del pronoto a U o a V; edeago con lunghissimo tubulo
sporgente dall'orifizio apicale 12

-     Pronoto con depressione posteriore a lati paralleli o con fossetta posteriore 14

12   Corpo unicolore nero-bruno, con zampe nero-brune o brune; margine
posteriore del sesto urotergo libero del ♂ con uno o tre larghi lobi e poco
sporgenti 13

-     Corpo tricolore giallo-rossiccio, con capo ed elitre bruno-rossicci e base
dell'addome rossiccia; zampe giallo-rossicce; margine posteriore del
sesto urotergo libero del ♂ cinque lobi sporgenti. Lungh. 2,5 mm.
Borneo: Sandakan . . . . *C. ashei* Pace

13   Margine posteriore del sesto urotergo libero del ♂ con tre lobi tra le
spine laterali; edeago con spina ventrale. Lungh. 2,6 mm. Borneo: Mt.
Kinabalu . . . . *C. spinae* sp. n.

-     Margine posteriore del sesto urotergo libero del ♂ con un solo lobo
mediano tra i lobi laterali; edeago senza spina ventrale. Lungh. 2,8 mm.
Borneo: Mt. Kinabalu . . . . *C. pallipes* sp. n.

14   Antenne e corpo unicolori nero pece; una fossetta mediana posteriore;
margine posteriore del sesto urotergo libero del ♂ con numerosi denti-
ni. Lungh. 2,8 mm. Borneo: Brunei . . . . *C. bruneiensis* sp. n.

-     Antenne brune con undicesimo antennomero giallo con base rossiccia;
corpo bicolore giallo-rossiccio e bruno; margine posteriore del sesto
urotergo libero del ♂ con quattro lobi mediani, i laterali con margine
seghettato. Lungh. 2,1 mm. Borneo: Mt. Kinabalu . . . *C. subrhomboidalis* sp.n.

15   Pronoto poco trasverso, con rapporto larghezza/lunghezza pari a 1,13-
1,15 16

-     Pronoto molto trasverso, con rapporto larghezza/lunghezza pari a 1,27-
1,57 17

16   Pronoto con due fossette mediane basali; elitre con forti punti assai ra-
di; margine posteriore del sesto urotergo libero del ♂ con largo lobo
seghettato ai margini laterali. Lungh. 2,5 mm. Borneo: Mt. Kinabalu
. . . . *C. magnilobata* sp. n.

-     Pronoto con una fossetta mediana basale; elitre con granulosità distinta;
margine posteriore del sesto urotergo libero del ♂ con numerose spine e
lobi. Lungh. 2,2 mm. Borneo: Mt. Kinabalu . . . . *C. lucidula* sp. n.

17   Margine posteriore del sesto urotergo libero del ♂ con sei piccoli lobi
mediani. Lungh. 2,1 mm. Borneo: Mt. Kinabalu . . . . . . *C. mimoleptusa* sp. n.

\- Margine posteriore del sesto urotergo libero del ♂ con un grande lobo mediano 18

18 Margine posteriore del sesto urotergo libero del ♂ con lobo mediano inciso a metà all'apice 19

\- Margine posteriore del sesto urotergo libero del ♂ con lobo mediano intero 21

19 Addome unicolore giallo-rossiccio o bruno; edeago non dilatato ai lati, in visione ventrale 20

\- Addome bicolore rossiccio con quarto urite libero bruno-rossiccio; edeago fortemente dilatato al lati, in visione ventrale. Lungh. 2,6 mm. Borneo: Mt. Kinabalu . . . . *C. rhomboidalis* sp. n.

20 Addome giallo-rossiccio; apice dell'edeago acuto. Lungh. 2,2 mm. Borneo: Mt. Kinabalu . . . . *C. microincisa* sp. n.

\- Addome bruno; apice dell'edeago largamente arcuato. Lungh. 2,2 mm. Borneo: Mt. Kinabalu . . . . *C. cristamagna* sp. n.

21 Corpo unicolore giallo-rossiccio; margine posteriore del sesto urotergo libero del ♂ con lobo mediano composto da tre piccoli lobi. Lungh. 1,8 mm. Borneo: Mt. Kinabalu . . . . *C. trilobata* sp. n.

\- Corpo bicolore giallo-rossiccio, con tre quarti posteriori delle elitre bruni; margine posteriore del sesto urotergo libero del ♂ con un solo lobo seghettato lateralmente o con un lobo composto da quattro piccoli lobi 22

22 Pronoto più trasverso, con rapporto larghezza/lunghezza pari a 1,37; margine posteriore del sesto urotergo libero del ♂ con lobo mediano composto da quattro piccoli lobi. Lungh. 1,7 mm. Borneo: Mt. Kinabalu . . . . *C. quadrilobata* sp. n.

\- Pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,27; margine posteriore del sesto urotergo libero del ♂ con un lungo lobo mediano seghettato lateralmente. Lungh. 2,0 mm. Borneo: Mt. Kinabalu . . . . *C. pansa* sp. n.

CHIAVE DELLE ♀ ♀ DELLE SPECIE DEL BORNEO DEL GENERE *COENONICA*

1 Quarto antennomero lungo quanto largo o più lungo che largo 2

\- Quarto antennomero trasverso 11

2 Quarto antennomero più lungo che largo 3

\- Quarto antennomero lungo quanto largo 8

3 Capo, pronoto ed elitre superficialmente punteggiati o finemente granulosi; spermateca ovale o piriforme. Lungh. 2,7 mm. Borneo: Mt. Kinabalu . . . . *C. kinabaluicola* sp. n.

\- Capo, pronoto ed elitre fortemente punteggiati o grossolanamente granulosi 4

4 Pronoto debolmente trasverso, con rapporto larghezza/lunghezza pari a 1,25; quarto urotergo libero con fossette laterali; bulbo distale della spermateca molto sviluppato ed ellittico. Lungh. 3,8 mm. Borneo: Mt. Kinabalu . . . . *C. obscuripalpi* sp. n.

-       Pronoto nettamente trasverso, con rapporto larghezza/lunghezza pari a
        1,31-1,71; quarto urotergo libero senza fossette laterali; bulbo dustale
        della spermateca grande e sferico, se ellittico ha dimensioni ridotte 5
5   Bulbo distale della spermateca ridotto ed ellittico; "ductus" conformato
        a formare un lungo bulbo prossimale. Lungh. 2,5 mm. Borneo: Mt. Mulu
        . . . . *C. muluensis* sp. n.
-       Bulbo distale della spermateca molto sviluppato e sferico; "ductus" a
        base larga e tubuliforme 6
6   Pronoto senza fossetta mediana basale posteriore. Lungh. 2,8 mm.
        Borneo: Mt. Kinabalu . . . . *C. perpunctata* sp. n.
-       Pronoto con due fossette basali mediane posteriori 7
7   Occhi ridotti, molto più corti delle tempie; antenne brune con apice
        dell'undicesimo antennomero giallo-rossiccio. Lungh. 2,9 mm. Borneo:
        Mt. Kinabalu . . . . *C. troglobia* sp. n.
-       Occhi molto sviluppati, più lunghi delle tempie; antenne bruno-rossicce
        con undicesimo antennomero giallo con base giallo-rossiccia. Lungh.
        2,0 mm. Borneo: Mt. Kinabalu . . . . *C. burckhardti* sp. n.
8   Punteggiatura o granulosità del capo e del pronoto poco distinte 9
-       Punteggiatura o granulosità del capo e del pronoto forte 10
9   Pronoto poco trasverso, con rapporto larghezza/lunghezza pari a 1,13 e
        con solchi molto prolungati in avanti, oltre il disco dello stesso pronoto;
        granulosità delle elitre poco distinta; bulbo distale delle spermateca
        ovale. Lungh. 2,8 mm. Borneo: Mt. Kinabalu . . . . *C. soror* Cameron
-       Pronoto nettamente trasverso, con rapporto larghezza/lunghezza pari a
        1,40 e con solchi corti in avanti, non superanti il disco dello stesso
        pronoto; granulosità delle elitre distinta; bulbo distale delle spermateca
        sferico. Lungh. 2,1 mm. Borneo: Mt. Kinabalu . . . . . *C. subrhomboidalis* sp. n.
10   Corpo unicolore nero-bruno, con zampe dello stesso colore; bulbo
        distale della spermateca con introflessione apicale vestigiale. Lungh. 2,6
        mm. Borneo: Mt. Kinabalu . . . . *C. spinae* sp. n.
-       Corpo tricolore giallo-rossiccio, con capo ed elitre bruno-rossicci e base
        dell'addome rossiccia; zampe giallo-rossicce; bulbo distale della sper-
        mateca senza traccia di introflessione apicale. Lungh. 2,5 mm. Borneo:
        Sandakan . . . . *C. ashei* Pace
11   Pronoto con una fovea o depressione mediano posteriore 12
-       Pronoto con due solchi mediani posteriori 13
12   Capo con una lieve impressione mediana; pronoto con una fovea
        mediana posteriore; avancorpo nero, con pronoto nero-bruno. Lungh.
        2,4 mm. Borneo: Samawang . . . . *C. abdominalis* Cameron
-       Capo senza impressione mediana; pronoto con depressione mediana
        posteriore; avancorpo bruno-rossiccio. Lungh. 2,5 mm. Borneo: Mt.
        Kinabalu . . . . *C. borneensis* Cameron
13   Pronoto poco trasverso, con rapporto larghezza/lunghezza pari a 1,15-1,17 . 14
-       Pronoto nettamente trasverso, con rapporto larghezza/lunghezza pari a
        1,23-1,45 15

14 Capo, pronoto ed elitre coperti da granulosità forte; presenza di solco discale mediano del capo; due solchi obliqui sul pronoto, che presenta un'impressione mediana anteriore. Lungh. 2,2 mm. Borneo: Mt. Pais .... *C. rifiventris* Cameron

\- Capo e pronoto punteggiati; elitre con forti punti assai radi. Lungh. 2,5 mm. Borneo: Mt. Kinabalu .... *C. magnilobata* sp. n.

15 Bulbo distale della spermateca reniforme 16
\- Bulbo distale della spermateca sferica o piriforme 17

16 Capo con fossetta discale; pronoto più trasverso, con rapporto larghezza/lunghezza pari a 1,45; addome bicolore bruno-rossiccio con quarto urite libero bruno; profilo distale della spermateca con un angolo retto. Lungh. 2,1 mm. Borneo: Mt. Matang ...... *C. sarawakensis* Cameron

\- Capo senza fossetta discale; pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,23; addome unicolore bruno-rossiccio con quarto urite libero bruno; profilo distale della spermateca quasi retti-lineo. Lungh. 2,7 mm. Borneo: Mt. Kinabalu .... *C. monticola* Cameron

17 Granulosità del pronoto poco distinta o confusa nella reticolazione 18
\- Granulosità del pronoto saliente 19

18 Corpo unicolore giallo-rossiccio; pronoto più trasverso, con rapporto larghezza/lunghezza pari a 1,46; reticolazione delle elitre superficiale; spermateca più sviluppata. Lungh. 1,8 mm. Borneo: Mt. Kinabalu .... *C. trilobata* sp. n.

\- Corpo bicolore giallo-rossiccio, con tre quarti posteriori delle elitre bruni; pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,27; reticolazione delle elitre netta; spermateca meno sviluppata. Lungh. 2,0 mm. Borneo: Mt. Kinabalu .... *C. pansa* sp. n.

19 Solchi del pronoto corti, non raggiungenti il disco; bulbo distale della spermateca sferico e molto sviluppato. Lungh. 2,2 mm. Borneo: Mt. Kinabalu .... *C. cristamagna* sp. n.

\- Solchi del pronoto prolungati fin oltre il disco; bulbo distale della sper-mateca sferico e minuscolo od ovale di media grandezza 20

20 Addome bicolore rossiccio con fascia posteriore bruno-rossiccia; sper-mateca minuscola, con bulbo distale sferico. Lungh. 2,6 mm. Borneo: Mt. Kinabalu .... *C. rhomboidalis* sp. n.

\- Addome unicolore giallo-rossiccio; spermateca con bulbo distale ovale e a pareti ispessite. Lungh. 2,2 mm. Borneo: Mt. Kinabalu .... *C. microincisa* sp. n.

Mimopisalia leptusoides sp. n.   Figg. 155-158

Holotypus ♂, Sabah, Mt. Kinabalu N.P., above Gunting Lagadan, 3400 m, 6.VIII.1988, A. Smetana leg. (MHNG).

Paratypi: 20 es., stessa provenienza; 11 es., Sabah, Mt. Kinabalu, 3300 m, Panar Laban, 4.V.1987, leg. Burckhardt & Löbl; 1 ♂, Sabah, Mt. Kinabalu Nat. Pk., Paka Cave, 2995 m, 5.V.1987, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,8 mm. Corpo lucido e bruno, con pigidio giallo-ros-siccio; antenne rossicce; zampe giallo-rossicce. La punteggiatura del capo è superfi-
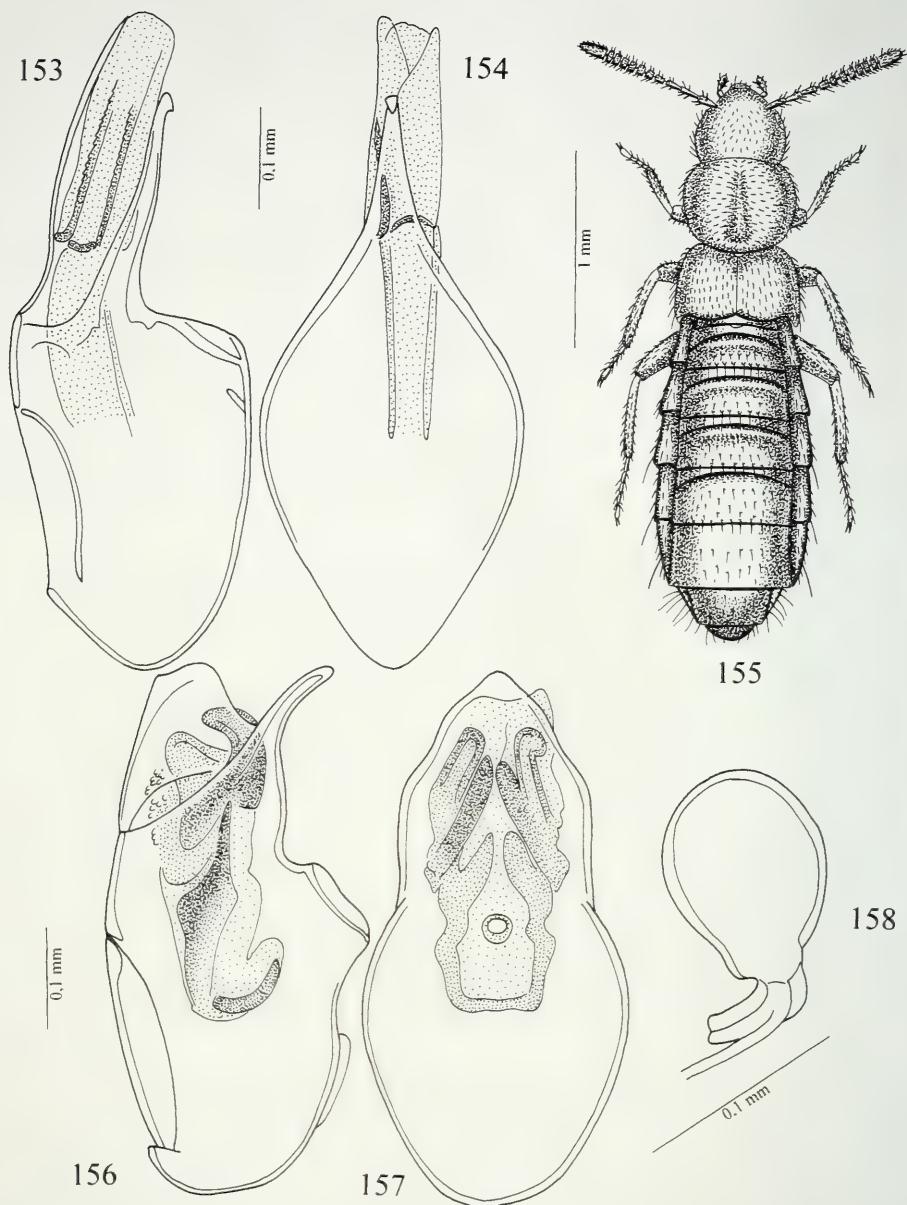
FIGG. 153-158

Edeago in visione laterale e ventrale, habitus, e spermateca. 153-154: *Coenonica perpunctata* sp. n.; 155-158: *Mimopisalia leptusoides* sp. n.

ciale e assente sul disco. Il pronoto non presenta né punteggiatura né granulosità. La granulosità delle elitre è poco evidente, quella dell'addome è fine. La reticolazione del capo è netta, quella del pronoto è vigorosa, quella delle elitre è distinta e quella del quinto urotergo libero è vigorosa. Edeago figg. 156-157, spermateca fig. 158.

COMPARAZIONI. La nuova specie è simile a *M. kinabaluensis* Pace, 1989, da cui si distingue per la punteggiatura del capo superficiale, il pronoto meno trasverso, le elitre più corte, per l'edeago più sviluppato, con armatura interna più robusta e per il bulbo distale della spermateca meno ovale.

ETIMOLOGIA. L'habitus della nuova specie è simile a quello di specie attere del genere *Leptusa* Kraatz. Per questo è chiamata "con aspetto di *Leptusa*".

Mimopisalia evoluta sp. n. Figg. 159-162

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu N.P., below Layang Layang, 2590 m, 1.V.1987, leg. A. Smetana (MHNG).
Paratypi: 1 ♂, Borneo-Sabah, Mt. Kinabalu N.P., below Layang Layang, 2595 m, 2.V.1987, leg. A. Smetana; 1 ♂, Borneo, Sabah, M. Kinabalu N.P., below Laban Rata, 3150 m, 7.VIII.1988, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,2 mm. Corpo lucido e rossiccio; antenne rossicce con i tre antennomeri basali giallo-rossicci; zampe giallo-rossicce. La punteggiatura del capo è indistinta. La granulosità del pronoto e delle elitre è distinta, quella dell'addome è saliente. La reticolazione del capo e delle elitre è distinta, quella del pronoto è nettissima e quella dell'addome è composta da maglie poligonali irregolari chiaramente visibili. Edeago fig. 160-161, sesto urotergo libero del ♂ fig. 162.

COMPARAZIONI. La nuova specie è vicina a *M. borneensis* (Cameron, 1933). Se ne distingue per le elitre più lunghe, pronoto nettamente più trasverso, per l'intercapedine apicale dell'edeago stretta e per la notevole differenza di forma del margine posteriore del sesto urotergo libero del ♂.

ETIMOLOGIA. Il nome "evoluta" della nuova specie sottolinea la sua differenza rispetto a *M. borneensis* (Cameron, 1933).

Mimopisalia smetanai sp. n. Figg. 163-167

Holotypus ♂, Borneo, Sabah, Mt. Kinabalu N.P., summit tr. Pondok Lowii, 2300-2400 m, 28.IV.1987, A. Smetana leg. (MHNG).
Paratypi: 34 es., stessa provenienza; 3 es., Borneo-Sabah, Mt. Kinabalu N.P., below Layang Layang, 2590 m, 1.V.1987, leg. A. Smetana.

DESCRIZIONE. Lungh. 2,4 mm. Avancorpo debolmente opaco, addome lucido. Corpo bruno-rossiccio, con pigidio rossiccio; antenne brune, con i tre antennomeri basali rossicci; zampe giallo-rossicce. La punteggiatura del capo è assente largamente sul disco, ai lati è fittissima, quella dell'addome è assente. La granulosità delle elitre è confusa, quella dei due uroterghi basali è saliente e quella dei restanti uroterghi è superficiale. La reticolazione del capo e del pronoto è vigorosa, quella delle elitre e dell'addome è svanita, solo nel fondo dei solchi trasversi basali degli uroterghi è netta. Edeago figg. 164-165, sesto urotergo libero del ♂ fig. 167, spermateca fig. 166.

COMPARAZIONI. La forma dell'edeago della nuova specie è simile a quello di *M. kinabaluensis* (Cameron, 1933). Ma la nuova specie ha elitre più lunghe del pronoto, mentre nella specie a confronto sono più corte del pronoto.
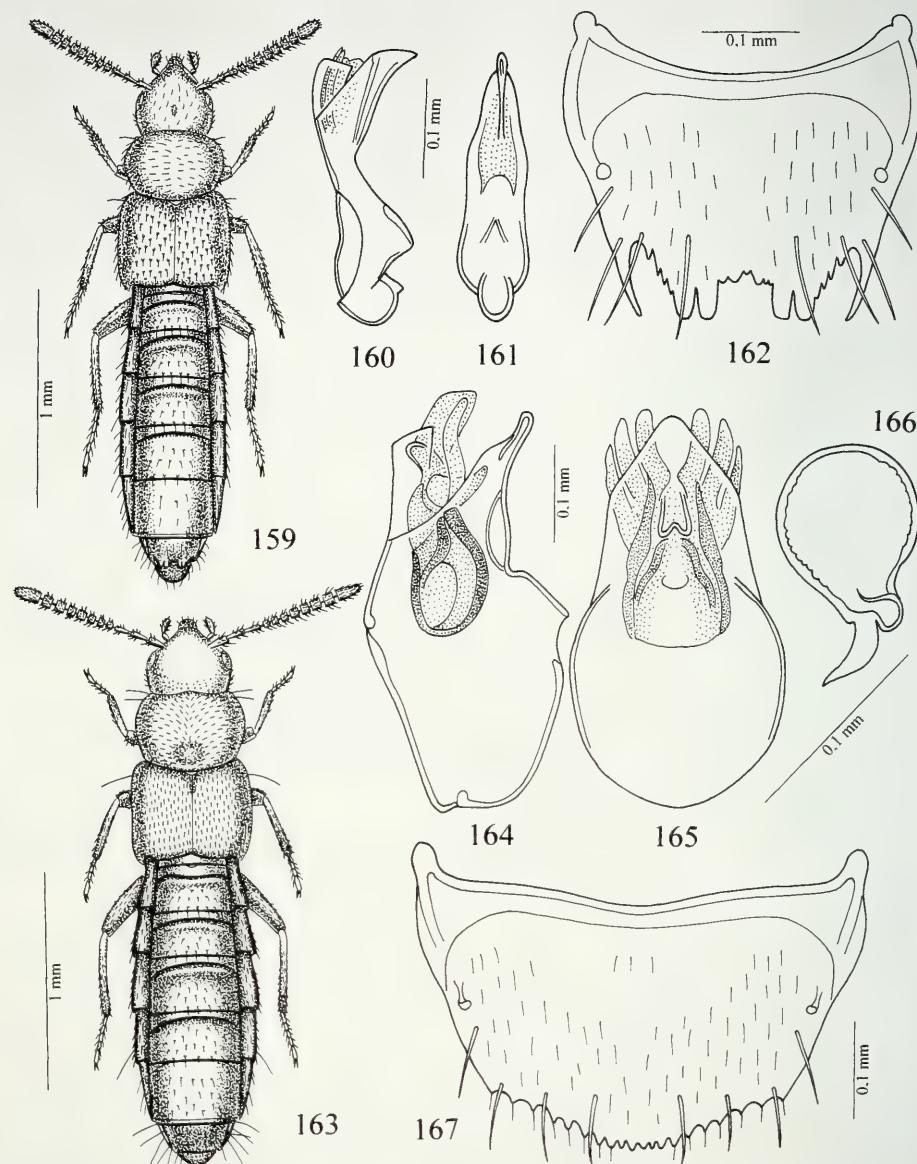
Habitus, edeago in visione laterale e ventrale, sesto urotergo libero del ♂ e spermateca. 159-162: *Mimopisalia evoluta* sp. n.; 163-167: *Mimopisalia smetanai* sp. n.

ETIMOLOGIA. La nuova specie è dedicata al suo raccoglitore, l'insigne stafilini-dologo Dr. Ales Smetana dell' "Eastern Cereal and Oilseed Research Centre" di Ottawa, Ontario.

Mimopisalia problematica sp. n. Figg. 168-169

Holotypus ♀, Borneo, Sabah, Mt. Kinabalu N.P., below Layang Layang, 2600 m, 2-8.V.1987, int. trap, A. Smetana leg. (MHNG).

DESCRIZIONE. Lungh. 1,8 mm. Corpo lucido e giallo-bruno; antenne brune con i tre antennomeri basali e l'undicesimo giallo-rossicci; zampe giallo-rossicce. La granulosità del capo e del pronoto è superficiale, quella delle elitre è distinta e quella dell'addome è saliente. Il quinto urotergo libero della ♀ presenta granulosità più forte di quella dei precedenti uroterghi. La reticolazione dell'avancorpo è superficiale, quella dell'addome è distinta. Spermateca fig. 169.

COMPARAZIONI. La nuova specie si distingue dalle altre del genere per le sue elitre particolarmente lunghe, più lunghe anche di quelle di *M. smetanai* sp. n., sopra descritta. La larga introflessione apicale del bulbo distale della spermateca distingue ulteriormente la nuova specie da quelle note che presentano bulbo distale della spermateca senza introflessione apicale.

ETIMOLOGIA. L'assenza del ♂ della nuova specie ha reso problematico il suo inquadramento tassonomico, che in futuro, con il ritrovamento del ♂ potrebbe subire mutamenti.

CHIAVE DELLE SPECIE DEL BORNEO DEL GENERE *MIMOPISALIA*

1 Elitre più corte del pronoto 2
- Elitre più lunghe del pronoto 4
2 Quarto antennomero trasverso; margine posteriore del sesto urotergo libero del ♂ con sei lobi irregolari, disposti su linea retta, tra le spine laterali; intercapedine apicale dell'edeago molto lunga e larga; bulbo distale della spermateca subreniforme. Lungh. 2,4 mm. Borneo: Mt. Kinabalu . . . . *M. borneensis* (Cameron)
- Quarto antennomero lungo quanto largo o più lungo che largo; margine posteriore del sesto urotergo libero del ♂ rettilineo; intercapedine apicale dell'edeago molto stretta; bulbo distale della spermateca ellittico 3
3 Antenne brune con apice dell'undicesimo antennomero gialli; quarto antennomero lungo quanto largo; capo distintamente punteggiato; pronoto più trasverso, con rapporto larghezza/lunghezza pari a 1,25; edeago meno sviluppato, profondamente arcuato al lato ventrale, con armatura interna meno sviluppata; bulbo distale della spermateca ovale allungato. Lungh. 2,1 mm. Borneo: Mt. Kinabalu . . . . *M. kinabaluensis* Pace
- Antenne unicolori rossicce; quarto antennomero più lungo che largo; capo superficialmente punteggiato, senza punteggiatura sul disco; pronoto meno trasverso, con rapporto larghezza/lunghezza pari a 1,21; edeago più sviluppato, con profilo ventrale bisinuato, in visione laterale, e con armatura interna più sviluppata; bulbo distale della spermateca ovale corto. Lungh. 2,8 mm. Borneo: Mt. Kinabalu . . . . *M. leptusoides* sp. n.

4   Antenne brune, con undicesimo antennomero giallo-rossiccio; elitre
        molto più lunghe del pronoto. Lungh. 1,8 mm. Borneo: Mt. Kinabalu
        . . . . *M. problematica* sp. n.
-       Antenne rossicce o brune con undicesimo antennomero mai di colore
        differente; elitre meno lunghe 5
5   Margine anteriore del pronoto arcuato; assenza di fossette del pronoto;
        margine posteriore del sesto urotergo libero del ♂ con quattro lobi e
        numerose spine; edeago esile, con un solo tubulo interno. Lungh.
        2,2 mm. Borneo: Mt. Kinabalu . . . . *M. evoluta* sp. n.
6   Margine anteriore del pronoto bisinuato; presenza di fossette mediane
        posteriori del pronoto; margine posteriore del sesto urotergo libero del
        ♂ seghettato; edeago robusto, con forte armatura interna. Lungh.
        2,4 mm. Borneo: Mt. Kinabalu . . . . *M. smetanai* sp. n.

Neosilusa terminalis sp. n.   Figg. 170-174

        Holotypus ♂, Borneo, Sabah, Mt. Kinabalu Nat.Pk., HQ at Liwagu Rv., 1500 m,
30.IV.1987, A. Smetana leg. (MHNG).
        Paratypi: 7 es., stessa provenienza; 1 es., Borneo, Sabah, Mt. Kinabalu, 1750 m,
21.IV.1987, Burckhardt & Löbl leg.; 1 es., Borneo, Sabah, Mt. Kinabalu N.P., HQ at Liwagu Rv.,
1560-1640 m, 24.IV.1987, A. Smetana leg.; 2 ♀♀ e 6 es.,, Borneo, Sabah, Mt. Kinabalu N.P.,
HQ at Liwagu Rv., 1500 m, 25.IV.1987, A. Smetana leg.; 1 es., Borneo, Sabah, Mt. Kinabalu
N.P., HQ at Liwagu Rv., 1500-1550 m, 27.IV.1987, A. Smetana leg.; 4 es., , Borneo, Sabah, Mt.
Kinabalu N.P.,1750 m, 27.IV.1987, Burckhardt & Löbl leg.;1 es., Borneo, Sabah, Mt. Kinabalu
Nat. Pk., HQ at Liwagu Rv., 1500 m, 30.IV.1987, leg. A. Smetana; 2 es., Borneo-Sabah, Crocker
Ra., 1550-1650 m, 16.V.1987, leg. Burckhardt & Löbl; 2 es., Borneo, Sabah, Crocker Ra., 1600
m, Km 51 rte. Kinabalu-Tambunan, 18.V.1987, Burckhardt & Löbl leg.; 31 es., Borneo-Sabah,
Mt. Kinabalu Nat. Pk., HQ Silau-Silau Tr., 1560 m, 3.VIII.1988, leg. A. Smetana; 2 es., Borneo,
Sabah, Mt. Kinabalu N.P., HQ at Liwagu Rv. tr., 1520 m, 11.IV.1988, A. Smetana leg.; 1 es.,
Borneo-Sabah, Mt. Kinabalu Nat. Pk., HQ Silau-Silau Tr., 1550 m, 2.IX.1988, leg. A. Smetana.
        DESCRIZIONE. Lungh. 2,9 mm. Corpo lucido e nero, con addome bruno-ros-
siccio; antenne rossicce con i tre antennomeri basali giallo-rossicci e l'undicesimo
giallo paglierino; zampe bruno-rossicce con tibie e tarsi rossicci. La granulosità del
capo e del pronoto è fittissima e forte, quella delle elitre è composta di granuli allun-
gati robusti, assenti presso il margine posteriore. Gli uroterghi sono nudi, tranne per la
presenza di alcune setole. La punteggiatura del fondo dei solchi trasversi basali degli
uroterghi in avanti è limitata da un archetto per ciascun punto. Edeago figg. 171-172,
sesto urotergo libero del ♂ fig. 174, spermateca fig. 173.
        COMPARAZIONI. Per il colore nero del corpo e la granulosità dell'avancorpo, la
nuova specie è sicuramente affine a *N. borneensis* (Cameron, 1928) ("olim" *Plagiusa*
Cameron, 1928: 416; *Neosilusa borneensis*: Bernhauer & Scheerpeltz, 1926: 540) del
Monte Murud. Le due specie si distinguono per i caratteri dati nella seguente chiave.

CHIAVE DELLE SPECIE DEL BORNEO DEL GENERE *NEOSILUSA*

1   Corpo rossiccio con metà posteriore delle elitre bruna 2
-    Corpo nero 3
2   Pronoto finemente granuloso; decimo antennomero più lungo che largo.
     Lungh. 2,3 mm. Sumatra, Mascarene, Madagascar, Borneo
     . . . . *N. tropica* (Bernhauer)
-    Pronoto rugosamente punteggiato o con punteggiatura estremamente fit-
     ta; decimo antennomero trasverso. Lungh. 2,4 mm. Mascarene, India,
     Malesia, Cina, Giappone, Borneo . . . . *N. ceylonica* (Kraatz)
3   Avancorpo subopaco; margine degli uroterghi oscuramente rossicci;
     terzo antennomero nero, undicesimo giallo-rossiccio; nono antennomero
     più lungo che largo. Lungh. 3,3 mm. Borneo: Mt. Murud.
     . . . . *N. borneensis* (Cameron)
-    Avancorpo lucido; margine degli uroterghi nero; terzo antennomero
     giallo-rossiccio, undicesimo giallo paglierino; nono antennomero
     trasverso. Lungh. 2,9 mm. Borneo: Mt. Kinabalu . . . . *N. terminalis* sp.n.

Linoglossa borneensis sp. n.   Figg. 175-176

Holotypus ♀, Sabah, Mt. Kinabalu, 3300 m, Panar Laban, 4.V.1987, leg. Burckhardt &
Löbl (MHNG).

DESCRIZIONE. Lungh. 2,5 mm. Corpo lucido e bruno, con pigidio rossiccio;
antenne perdute in fase di raccolta; zampe giallo-rossicce. La punteggiatura del capo è
indistinta. La granulosità del pronoto è assente, quella delle elitre è molto superficiale
e quella dell'addome è saliente. La reticolazione del capo è netta, quella del pronoto è
vigorosa, quella delle elitre è superficiale e quella degli uroterghi è distinta. Spermateca
fig. 176.

COMPARAZIONI. Finora il genere *Linoglossa* Kraatz non era noto per il Borneo.
La spermateca della nuova specie è simile a quella di *L. angustata* (Motschulsky, 1858)
dell'India. Se ne distingue per i caratteri della seguente chiave. L'esemplare di
L. angustata qui a confronto è il tipo ♀ di *L. bifoveolata* Kraatz, 1859, sinonimo di
L. angustata.

1   Capo con profondo solco longitudinale; depressione posteriore mediana
     del pronoto divisa da una carena longitudinale mediana; punteggiatura
     delle elitre netta e rada, irregolarmente distribuita; ognuno dei tre solchi
     basali dei tre uroterghi basali, con due foveole nel fondo; spermateca
     fig. 177. Lungh. 2,8 mm. India . . . . *L. angustata* (Motschulsky)
-    Capo senza solco longitudinale; depressione posteriore mediana del
     pronoto senza carena longitudinale mediana; elitre coperte di granulosità
     molto superficiale; solchi basali dei tre uroterghi basali, senza foveole
     nel fondo; spermateca fig. 176. Lungh. 2,5 mm . . . . *L. borneensis* sp. n.
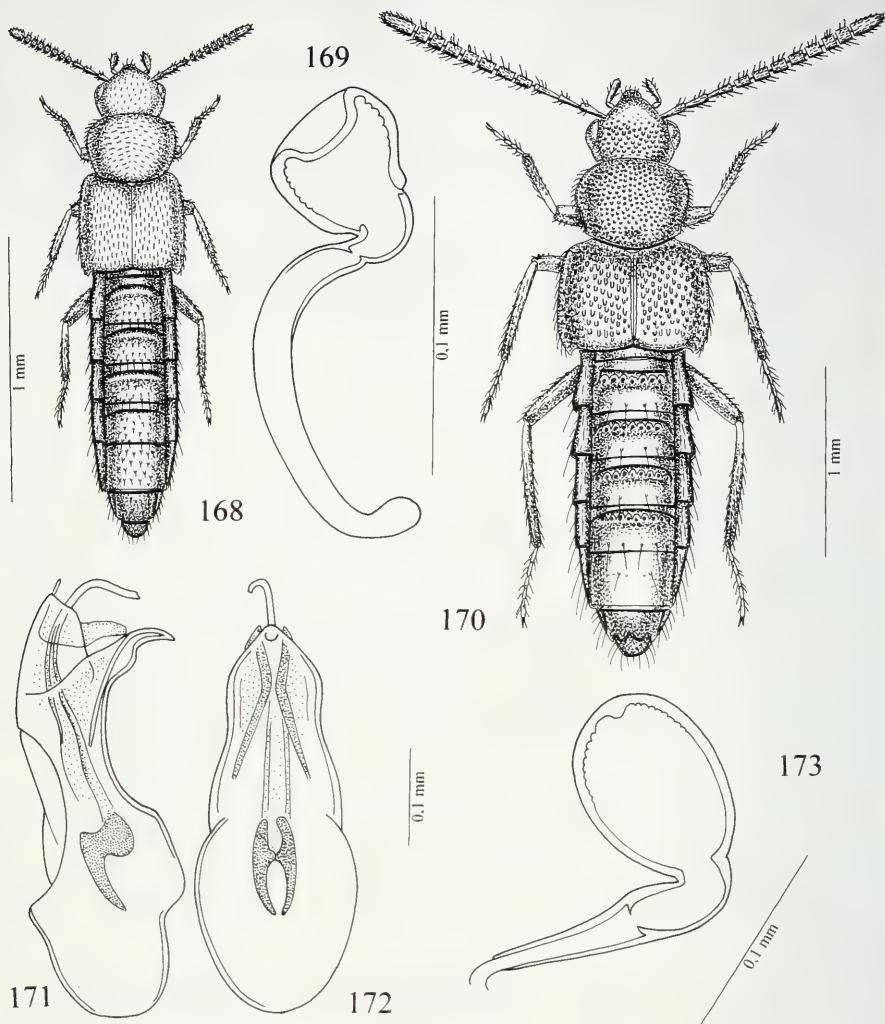
Habitus, spermateca ed edeago in visione laterale e ventrale. 168-169: *Mimopisalia problemati-ca* sp. n.; 170-173: *Neosilusa terminalis* sp. n.
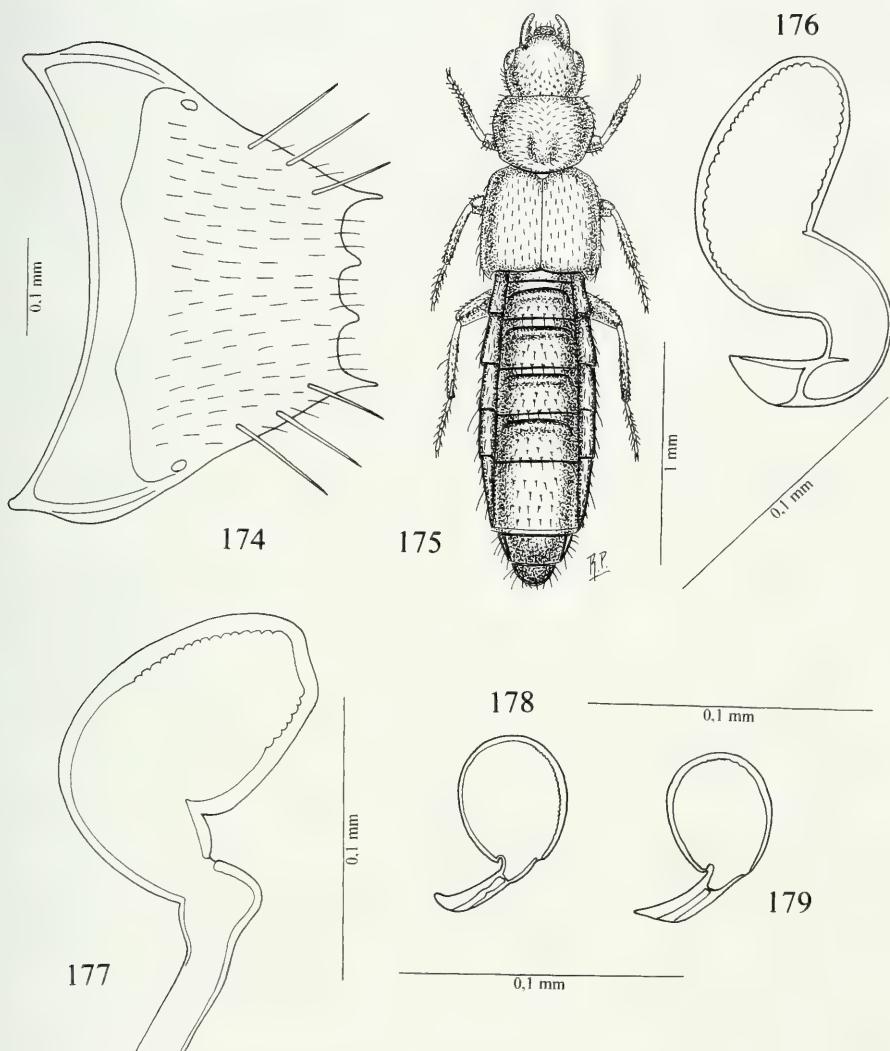
FIGG. 174-179

Sesto urotergo libero del ♂, habitus e spermateca.174: *Neosilusa terminalis* sp. n.; 175-176: *Linoglossa borneensis* sp. n.; 177: *Linoglossa angustata* (Motschoulsky); 178: *Coenonica soror* Cameron, holotypus; 179: *Coenonica nigrita* Cameron, holotypus, nuovo sinonimo di *Coeno-nica soror* Cameron.

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Redescription and new species of *Alexidia* (Coleoptera: Staphylinidae: Scaphidiinae)

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Redescription and new species of *Alexidia* (Coleoptera: Staphylinidae: Scaphidiinae). - The Neotropical genus *Alexidia* Reitter and its type species *A. rogenhoferi* Reitter are redescribed. Following additional new species are described: *A. carltoni* sp. n. from Ecuador, *A. dybasi* sp. n. from Panama, and *A. plaumanni* sp. n. from Brazil. A key to the species of *Alexidia* is provided.

Key-words: Coleoptera - Staphylinidae - Scaphidiinae - *Alexidia* - Neotropics - taxonomy.

INTRODUCTION

The present classification of Scaphisomatini is unclear with many genera requiring detailed study and redescription. The groupings of genera (Achard, 1924) apparently does not reflect monophyly and have been ignored in recent taxonomic treatments (Löbl, 1971, 1990, 1992). Because of this problem we are in the process of examining the phylogenetic relationships of the genera in an attempt to restructure the classification of the group, especially to place taxa like Neotropical *Alexidia*, which have not been studied since their description and are rare in collections. In this paper we redescribe the genus and its type species *Alexidia rogenhoferi* Reitter, 1880, and add three new species from Brazil, Ecuador, and Panama.

Several characters of *Alexidia rogenhoferi* were not examined because only a single type is available for study, and this specimen is in poor state.

Material is deposited in the following collections: Field Museum of Natural History, Chicago (FMNH), Muséum d'histoire naturelle, Genève (MHNG), Muséum d'Histoire Naturelle, Paris (MHNP), Museo de Zoologia, Pontificia Universidad Catolica del Ecuador, Quito (MZUC), New Zealand Arthropod Collection, Auckland (NZAC) and Snow Entomological Museum, University of Kansas (SEMC).

TAXONOMY

Alexidia Reitter, 1880

Alexidia Reitter, 1880: 43. Type species *Alexidia rogenhoferi* Reitter, 1880.

Diagnosis. Maxillary palpus aciculate. Antennomeres 3 and 4 elongate; 7, 9 and 10 each with long and narrow apical stalk and subapical rim of short setae in addition to long setae. Galea wider than long; brush apical and radulate. Surface of mentum with spines. Prothoracic corbiculum present. Metendosternum with stem present. Profemoral ctenidium absent. Mesotibia with a single ventral spine. Empodium bisetose.

Description. Dorsal vestiture reduced. Labral setae present and simple (not examined in *A. rogenhoferi*). Mandible bidentate apically, subapical serrations present (at least on left mandible). Maxillary palpus aciculate; one subapical seta present on palpus 2 (broken off in *A. rogenhoferi*). Galea wider than long; brush apical and radulate. Inner and basal setae absent from lacinia, but apical setae extending to subapical area. Hypopharynx with 2 setae on adoral surface; setae spinate. Labial palp 3-segmented; terminal labial palpomere not aciculate, inserted apically and strongly curved; subapical palpomere with one seta. Mentum (not examined in *A. rogenhoferi*) with anterior edge straight; surface with spines. Submaxillary area of head with microtubulate ducts present (not examined in *A. rogenhoferi*). Gular area with transverse clusture of pores (not examined in *A. rogenhoferi*). Frontoclypeal suture present. Eye entire. Antennal insertion below slight ridge and present at midline of eye. Antenna filiform (not seen in *A. rogenhoferi* which has only the scape and pedicel present in the type specimen but according to Reitter's description long and as in *Baeocera* Erichson); antennomeres 3 and 4 elongate; antennomeres 7, 9 and 10 each with long and narrow apical stalk and subapical rim of short setae in addition to long setae. Anterior tentorial tendon absent. Prothoracic corbiculum present. Prosternum poorly developed; anterior margin of procoxal cavity asetose. Hypomeron in lateral view completely visible; apex not projecting beyond pronotum. Prothoracic carina prominent with a bead; not completely visible in dorsal view. Anterior margin of pronotum with a bead. Posterior angle rounded and not extending below ventral edge of elytra; not extending to anapleural suture. Prosternum with spine present. Mesosternum with prepectus (mesosternal space); secondary and median lines absent. Mesosternal lines present; connecting with mesocoxal cavity, impunctate; not parallel with outer margins of procoxal rests. Mesosternal process paxillate. Mesepimeron absent or fused with mesosternum. Mesocoxa wider than intercoxal process; coxa round. Meso- and metasternum separate. Submesocoxal lines arcuate, impunctate or punctate. Metasternum without setose patch; primary setae present and located on the disc; transverse premetaxocal lines absent; descrimen absent; intercoxal plate present as a single plate. Metepisternal suture absent or present. Metepisternum visible in ventral view; posterior line absent. Metendosternum with stem present. Pteronotum with scutellum concealed below elytra; width about 1/2 entire width of pteronotum; transverse basal line or carina complete. Metacoxae separate. Brick-wall membranes present on abdominal ventrites 1 to 4. Ventrite one with intercoxal line; submetacoxal lines absent; submetacoxal bead impunctate; primary setae present. Primary setae present on

ventrites 2-4; 2 on each segment. Abdominal vestiture absent. Paratergites absent. Hind wings present or absent. Elytron with basal stria present or absent; sutural striae shortened or elongate; basal and sutural striae not connected; epipleural stria present; sutural spines and apical serrations absent. Metacoxal process triangular. Profemoral ctenidium absent. Mesofemora in cross-section rounded; subapical seta present and not spine like. Tibiae smooth. Mesotibia distinctly longer than mesotarsus; one ventral mesotibial spine present, about as long as two thirds of first tarsomere. Metatarsi smooth; mesotarsomere 1 slightly shorter than tarsomeres 2 and 3 combined. Empodium bisetose.

Discussion. Alexidia is similar to other members of Scaphisomatini, especially those taxa with aciculate maxillary palpi, elongate antennomeres 3, and basal pronotal angles rounded and not extending to anapleural suture. Whereas other Scaphisomatini, membres of *Scaphoxium* Löbl excepted, have two ventral mesotibial spines, *Alexidia* can be distinguished from them by having a single spine (Fig. 4). *Scaphoxium* has approximate coxal cavities, and is very distinctive from *Alexidia*. The aedeagus of *Alexidia* has an elongate and symmetrical internal sac with tripartite basal sclerites that are similar to those seen in species of New Zealand *Brachynopus* Broun, and a very long, irregularly folded ejaculatory duct inside the median lobe (Fig. 5). Members of *Amalocera* Erichson have also the ejaculatory duct much longer than the median lobe (Löbl, 1974) but it is coiled, sclerotized and forms a flagellum. A very long, membranous ejaculatory duct is present also in the species rich *Baeocera* group *lenta* (Löbl, 1971, 1992). In these species the ejaculatory duct is everted outside the median lobe, the sclerites of the internal sac are distinctive, and the basal angles of pronotum extend below the edge of the elytra. *Alexidia* may be readily distinguished from *Amalocera* by the abruptly narrowed and long apical part of the antennomeres 7, 8 and 9 (Fig. 1), the aciculate apical segment of maxillary palpi (Fig. 3), the lacinia with setae (Fig. 3) situated apically while in *Amalocera* (Fig. 2) the setae are present also on the subapical margin of the lacinia. Despite the similarity to *Amalocera* and *Brachynopus*, the relationship of *Alexidia* to other members of Scaphisomatini is uncertain and must await further analysis.

Key to the species of *Alexidia*

1   Elytra with sutural striae shortened, not extended to base 2
-    Elytra with sutural stria entire, extended from apex to base 3
2   Elytra lacking basal striae . . . . *A. rogenhoferi* Reitter
-    Elytra with basal striae . . . . *A. carltoni* sp. n.
3   Elytral punctation much more distinct that pronotal punctation. Hind
     wings reduced. Metepisteral suture present . . . . *A. plaumanni* sp. n.
-    Elytra and pronotum with similar, very fine punctation. Hind wings
     developed. Metepisternal suture absent . . . . *A. dybasi* sp. n.

Alexidia rogenhoferi Reitter, 1880

Syntype female, labelled: Neugranada Chevrolat (hand written) / Rogenhoferi Rttr / (hand written)/ TYP. REITTER (printed) / TYPE (red, printed) / Muséum Paris Coll. Générale (printed) (MHNP).

Description. Length 1.45 mm. Body strongly convex dorsally, moderately convex ventrally. Body and appendages light reddish-brown, tibiae and tarsi slightly lighter than femora. Head with frons wide, about 2.5 times as broad as eyes long. Eyes flat, shorter than dorso-ventral eye diameter. Pronotum strongly narrowed anteriorly, with lateral edges strongly arcuate and lateral stria concealed (dorsal view). Apical stria entire, not interrupted at middle, at middle finer than laterally. Basal lobe short. Punctation, microsculpture and pubescence completely absent (200 times magnification). Hypomera not impressed, impunctate. Elytra strongly narrowed apically, with lateral edges and striae exposed in dorsal view. Apical margins truncate except at angles, edentate. Inner apical angle not prominent. Sutural striae short and shallow, slightly diverging anteriorly, from apex extending almost to sutural mid-length. Adsutural areas flat. Basal striae absent. Epipleura wide at base, gradually narrowed apically. Supra-epipleura oblique, large, lacking basal bead, equally wide in anterior half and about 1.5 times as wide as epipleura near base, gradually narrowed apically. Elytral punctation reduced, indicated by scattered darkened point, microsculpture absent. Hind wings absent. Ventral side of thorax impunctate and lacking microsculpture. Mesosternal shield flat, lacking striae or impression. Mesepimera and mesepisterna fused. Width of intercoxal process slightly smaller than mesocoxal width, about as width of metacoxal process. Metasternum short between meso and metacoxae, flattened in middle, lacking impressions. Submesocoxal lines arcuate, impunctate. Length of submesocoxal areas as about as half of shortest interval between submesocoxal lines and metacoxal margin. Metepisterna concealed, very narrow, with impunctate suture. Abdominal ventrites 1 and 2 impunctate, lacking microsculpture. Ventrite 1 lacking impressions. Tibiae almost evenly thick. Pro- and mesotibiae straight, metatibiae very weakly curved.

Male characters unknown.

Alexidia carltoni sp. n.   Figs 8-10

Holotype female: Ecuador Azuay 50km NW Cuenca 2470m, 2.Jan. 1992 C. Carlton, R. Leschen # 94 ex: berlese (SEMC). Paratypes: same data as holotype, 1 male 3 females (SEMC, MHNG, MZUC).

Description. Length 1.75 mm. Body strongly convex dorsally, moderately convex ventrally, piceous, apex of abdomen light brown to yellowish, appendages slightly lighter than body. Lateral contours of pronotum and elytra continuously arcuate. Head with frons wide, hardly twice as broad as eyes length. Eyes flat, shorter than dorso-ventral eye diameter. Antennae long, with segments 3 to 6 and 8 about equally wide, each bearing scattered, long setae. Apical half of antennal segment 11 with short pubescence, in addition to long, scattered setae. Pronotum strongly narrowed anteriorly, with lateral edges strongly arcuate and lateral stria concealed (dorsal view). Apical stria widely interrupted in middle. Basal lobe short. Punctation very fine, microsculpture absent, pubescence inconspicuous. Hypomera hardly impressed, as finely punctate as pronotum, with flat process posterior procoxae delimited by longitudinal stria. Scutellum concealed. Elytra strongly narrowed apically, with lateral edges and striae exposed in dorsal view. Apical margins truncate

except at angles, edentate. Inner apical angles not prominent. Sutural striae parallel, shallow, impunctate, shortened, extending up to anterior third of sutural length. Adsutural areas flat. Basal striae entire, very shallow, joined to lateral striae. Epipleura almost equally wide in anterior two thirds, narrowed posteriorly. Supra-epipleura oblique, large, delimited anteriorly by bead, widest at middle and at widest point slightly more than twice as wide as epipleura. Elytral punctation sparse and very fine, about as fine as that on pronotum. Hind wings absent. Mesepimera partly fused to metepisterna, with very fine suture, about as long as half of interval to mesocoxa. Mesepisterna and metasternum lacking microsculpture, very finely punctate. Metasternum narrow between meso- and metacoxae. Submesocoxal lines arcuate, very finely punctate. Submesocoxal areas shorter than interval between lines and meta-coxae. Metepisterna fused to metasternum, suture indicated by straight line. Abdominal ventrites distinctly microsculptured, impunctate. Ventrite 1 with very shallow lateral impressions. Ventrites 1 and 2 with one pair of primary setae, ventrites 3 and 4 with two pairs of primary setae. Submetacoxal line impunctate. Protibiae straight, narrowed basally, meso-and metatibiae almost evenly thick.

Male. Segments 1 to 3 of protarsi widened and bearing tenant setae, segment 1 almost as wide as apex of tibia. Meso- and metatibiae arcuate. Aedeagus 0.66 mm long, as Figs 8 to 10.

Female. Meso- and metatibiae weakly curved.

Comments. This species may be easily distinguished from *A. rogenhoferi* by the presence of elytral basal striae. In addition, it differs by the large body size, the basal part of supra-epipleura more than twice as wide as basal part of epipleura, and the mesepisterna only partly fused.

Alexidia plaumanni sp. n.   Figs 1, 3-7

Holotype male: Brazil: Santa Catharina; VIII. 1954, leg. F. Plaumann (MHNG).
Paratypes: Brazil, Nova Teutonia 27°11'S 52°23' W, 300-500m, I. 1957, F. Plaumann, 1 male, 2 females (NZAC, MHNG); same data but X.1956, 2 males (MHNG) and X. 1957, 1 female (FMNH); same data but VI. 1952, 2 males 1 female (MHNG).

Description. Length 1.8-2.1 mm. Similar to *A. carltoni* in most characters, differing as follows: Frons 2.5 times as wide as eye length. Pronotal punctation fairly dense and fine, visible at low (20 x) magnification. Elytra with sutural striae not shortened, joined to basal striae. Elytral punctation distinctly coarser than pronotal punctation. Supra-epipleura hardly 3 times as wide as epipleura. Mesosternal process lacking striae. Mesepimera distinct, oblique, very short, not extending beyond mesepisternal suture, hardly as long as third of interval to mesocoxa. Middle part of metasternum coarser punctate than lateral parts of metasternum, and with distinct, very short pubescence. Submesocoxal areas as long as or slightly longer than interval between submesocoxal lines and metacoxae. Mesocoxal process about as wide as 2/3 of mesocoxal width, narrower than metacoxal process. Metepisterna not fused to metasternum, with distinct, slightly curved suture. Abdominal ventrite 1 with lateral impression and distinctly punctate in middle, ventrites 1 and 2 with single pair of primary setae, ventrites 3 and 4 with 2 pairs of primary setae. Protibiae straight, narrowed basally, meso- and metatibiae almost evenly thick.
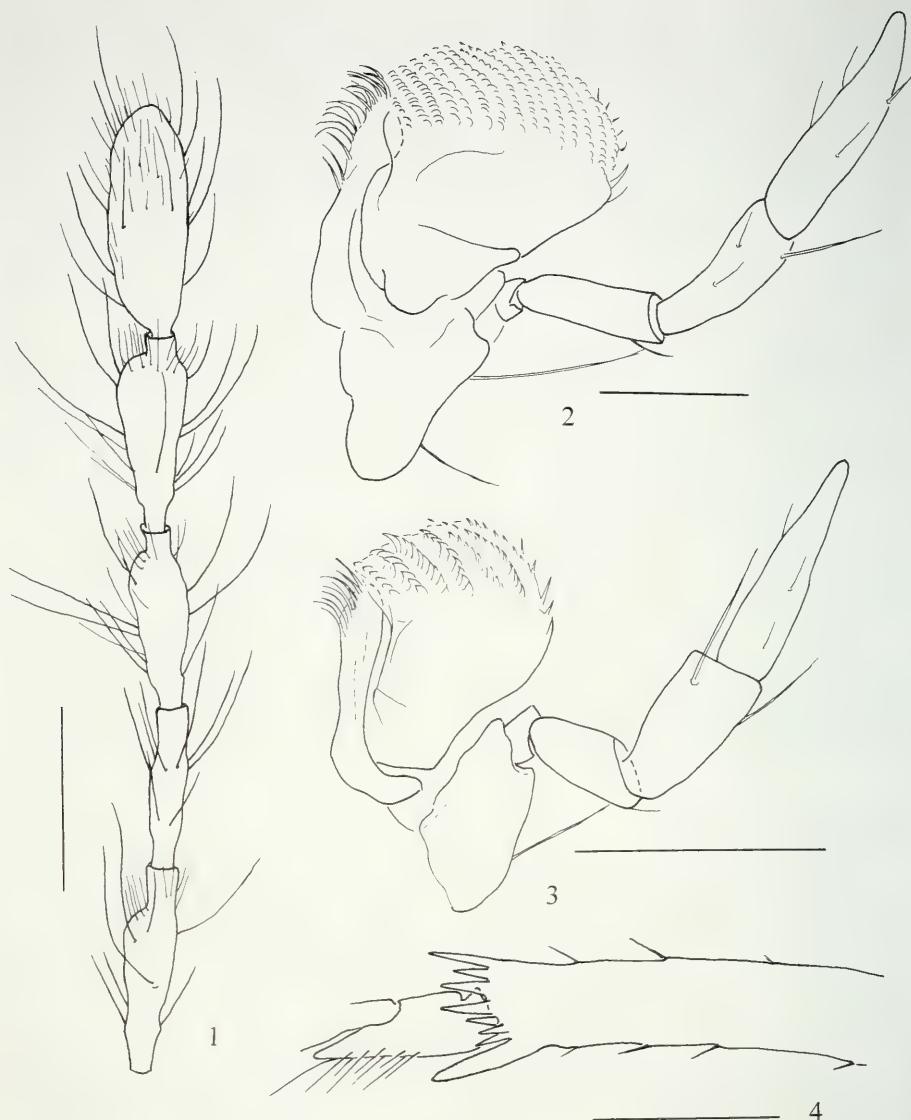
FIGS 1-4

1: *Alexidia plaumanni* sp. n., antennomeres 7 to 11; 2: *Amalocera dentipes* Löbl, maxilla with palpus; 3: *Alexidia plaumanni* sp. n., maxilla with palpus; 4: *Alexidia plaumanni* sp. n., apical part of mesotibia with basal tarsomere. Scale bars = 0.1mm.

Male. Protarsi with segments 1 to 3 widened, segment 1 about as wide as apex of protibiae. Meso- and metatibiae arcuate. Aedeagus 0.64 – 0.81 mm long, as Figs 5 to 7.

Female. Mesotibiae hardly curved, metatibiae slightly arcuate.
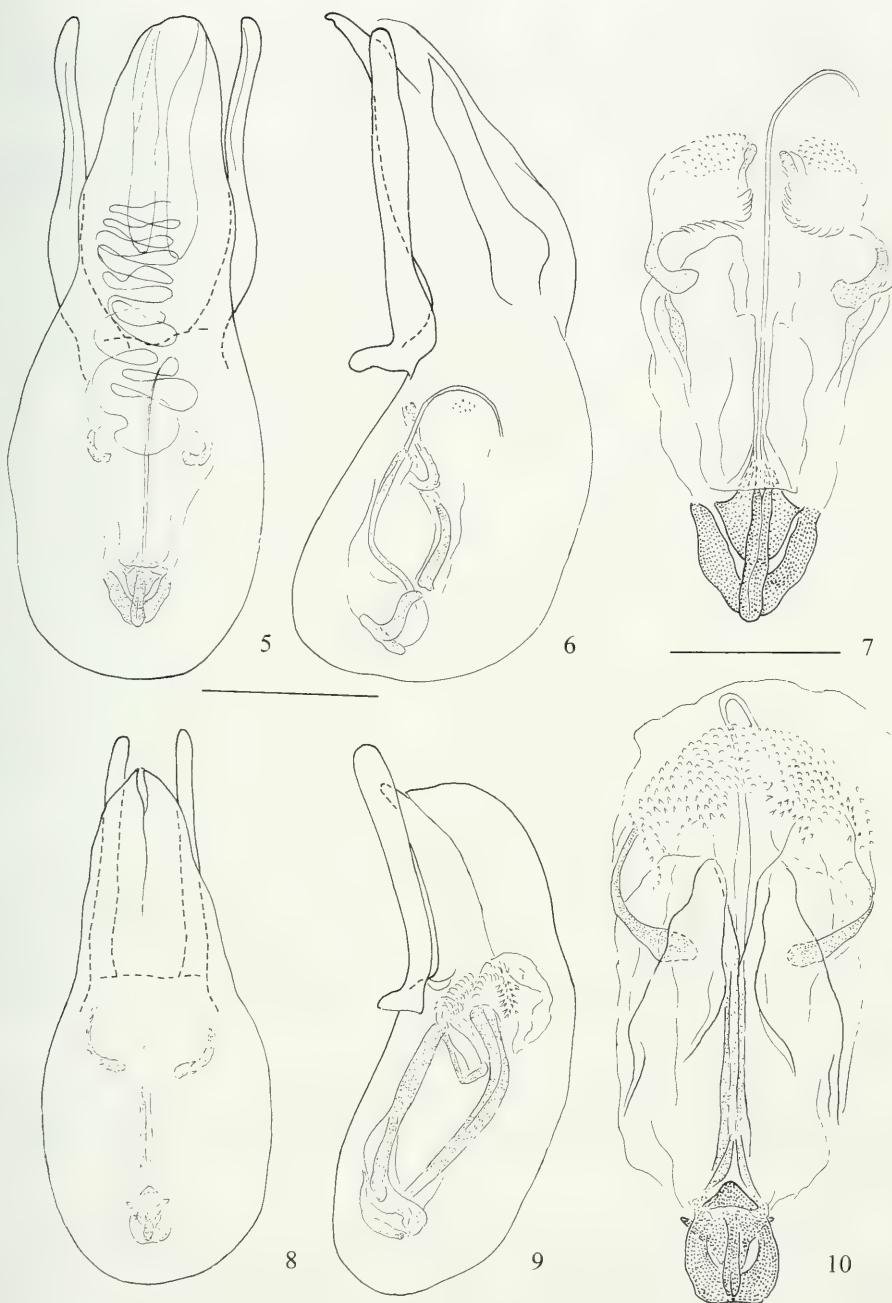
FIGS 5-10

Aedeagi in *Alexidia*. 5 to 7: *A. plaumanni* sp. n., internal sac (7) in detail; 8 to 10: *A. carltoni* sp. n., internal sac (10) in detail. Scale bars = 0.2 mm (5, 6, 8, 9) and 0.1 mm (7, 10).

Alexidia dybasi sp. n.   Figs 11- 14

Holotype male, labelled: El Valle, Cocle Prov. (tail to Las Minas) PANAMA; II: 23-1959
alt. 2400-2600ft./CNHM Panama Zool. Exped. (1959) H.S. Dybas leg./ground debris Berlese
(B-348) (FMNH).

Paratype female, with same data as holotype (MHNG).

Description. Length 1.4 – 1.55 mm. Body very dark, piceous, elytra lighter at
apex, apical abdominal segments and legs rufous, antennae distinctly lighter than legs.
Lateral contours of pronotum and elytra continuously arcuate. Head with frons
moderate wide, about 1.5 times as wide as eyes length. Eyes convex, about as long as
two thirds of dorso-ventral eye diameter. Antennae long, with segments 3 to 6 and 8
about equally wide, each bearing scattered, long setae. Apical half of antennal segment
11 with short pubescence, in addition to long, scattered setae. Pronotum strongly
narrowed anteriorly, with lateral edges strongly arcuate and lateral stria visible (dorsal
view). Apical stria entire, not interrupted in middle. Basal lobe short. Punctation very
fine, microsculpture absent, pubescence very fine but distinct. Hypomera weakly
impressed, as finely punctate as pronotum. Elytra strongly narrowed apically, with
lateral edges and striae exposed in dorsal view. Apical margins truncate except at
angles, edentate. Inner apical angles not prominent. Sutural striae diverging from apex
to mid-length, parallel anterior mid-length, shallow, impunctate, extending to and
along base to form basal striae joined to lateral striae. Adsutural areas flat. Epipleura
almost equally wide in anterior two thirds, narrowed posteriorly. Supra-epipleura
oblique, large, delimited anteriorly by bead, widest at middle and at widest point twice
as wide as epipleura. Elytral punctation sparse and very fine, about as fine as that on
pronotum. Hind wings well developed. Mesepimera with inner part completely fused
to metepisterna. Mesepisterna and metasternum lacking microsculpture, very finely
punctate. Metasternum narrow between meso- and metacoxae. Submesocoxal lines
arcuate, finely punctate mesally, impunctate laterally. Submesocoxal areas as long as
half of interval between lines and metacoxae. Mesocoxal process about as wide as
metacoxal process and as wide as three fourth of mesocoxal width. Metepisterna fused
to metasternum, suture indicated by straight, weak line. Abdominal ventrites distinctly
microsculptured, impunctate. Ventrite 1 lacking lateral impressions. Ventrites 1 and 2
with one pair of primary setae, ventrites 3 and 4 with two pairs of primary setae.
Submetacoxal line impunctate. Protibiae straight, narrowed basally, meso- and meta-
tibiae almost evenly thick.

Male. Protarsi with segments 1 to 3 moderately widened, much narrower than
apex of tibiae, with tenant setae. Mesotibiae and metatibiae distinctly curved, meso-
tibiae narrowed between mid-length and apical fifth. Aedeagus 0.52 mm long, as Figs
11 to 14.

Female. Meso- and metatibiae slightly arcuate.

Comments. This species may be distinguished from its congeners by the hind
wings well developed. It is similar to *A. plaumanni* in having elytra with entire sutural
striae but divers distinctly by the very fine elytral punctation and fused metepisterna.
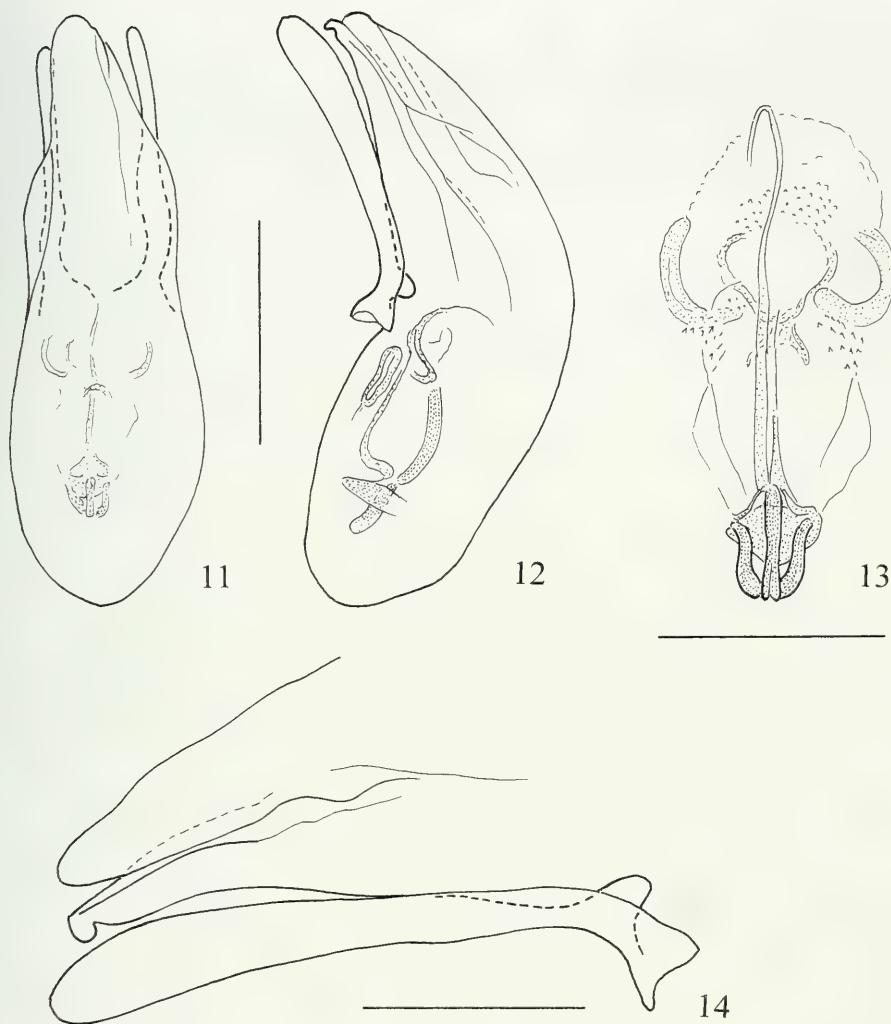
FIGS 11-14

Aedeagus in *Alexidia dybasi* sp. n., internal sac (13) in detail, apical part of median lobe and paramere (14) in lateral view at higher magnification. Scale bars = 0.2 mm (11, 12) and = 0.1 mm (13, 14).

ACKNOWLEDGEMENTS

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New records of Pauropoda (Myriapoda) with descriptions of new species from Rwanda and Réunion (Pauropoda and Symphyla of the Geneva Museum XII)

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New records of Pauropoda (Myriapoda) with descriptions of new species from Rwanda and Réunion (Pauropoda and Symphyla of the Geneva Museum XII). - A collection of 751 Pauropoda (Myriapoda) specimens has been studied. Three species are new to science and are described: *Allopauropus afer* sp. n. and *Samarangopus rwandaensis* sp. n. from Rwanda and *Sphaeropauropus reunionensis* sp. n. from Réunion and Sri Lanka. Thirty-five more species have been recognised and the species lists for many countries have been lengthened. The following species are here recorded for the first time from: Switzerland, 3 species [*Stylopauropus neglectus* Remy, *Acopauropus consobrinus* (Remy), *Trachypauropus cordatus* (Scheller)]; Greece, 3 species (*Allopauropus helophorus* Remy, *Brachypauropus superbus* Hansen, *Acopauropus attemsi* Hasenhütl); Slovenia, 2 species (*Pauropus bagnalli* Remy, *Stylopauropus limitaneus* Remy); the Maltese Islands, 3 species [*Allopauropus danicus* (Hansen), *A. gracilis* (Hansen), *A. helveticus* (Hansen)]; Turkey, 4 species [*Acopauropus hastatus* (Attems), *A. tetrastichus* Scheller, *Trachypauropus cordatus* (Scheller), *T. glomerioides* Tömösváry]; Réunion, 1 species (*Sphaeropauropus reunionensis* sp. n.); Sri Lanka, 2 species, (*Sphaeropauropus nepalensis* Scheller, *S. reunionensis* sp. n.); Malaysia, 1 species (*Allopauropus rastifer* Remy); Indonesia, 1 species [*Allopauropus danicus* (Hansen)]; Rwanda, 2 species (*Allopauropus afer* sp. n., *Samarangopus rwandaensis* sp. n.) and Argentina, 1 species (*Stylopauropoides subantarcticus* Scheller).

Key-words: Europe - Asia - Africa - Rwanda - Réunion - South America - Pauropoda - taxonomy - biogeography - soil zoology.

INTRODUCTION

The study of the taxonomy of Pauropoda was long limited to manually collected and therefore sparse material. During later years automatical extraction methods in combination with skilful sorting out assistants, have been of great importance for the

studies in several pedozoological fields, among them the biodiversity and distribution of Pauropoda.

Thanks to Dr Bernd Hauser, it has been possible to study valuable pauropods from the collections of the Natural History Museum, Geneva. A scattered material of various sizes from many countries and collected mainly by means of automatical extraction methods, a total of 751 specimens, was available for examination. Dr Hauser himself collected most of these specimens and his great faculty in finding valuable collecting sites has resulted in a rich material. Several other soil zoologists have contributed as well: Drs Villy Aellen[†], Claude Besuchet, Herman Gisin[†], Ivan Löbl, Volker Mahnert, Paul Schauenberg, who all have belonged to or are belonging to the staff of the Museum in Geneva. Moreover, some collectors outside the Museum, but in close contact with it, have deposited material studied here. They are: Dr Romano Dallai (Siena), Dr Egon Horak (Zürich), Dr Pierre Strinati (Cologny, Geneva), Dr Konrad Thaler (Innsbruck), and Dr Philippe Werner (Ollon-Chemignon).

Three species are new to science and are described. They are *Allopauropus afer* sp. n. and *Samarangopus rwandaensis* sp. n. from Rwanda and *Sphaeropauropus reunionensis* sp. n. from Réunion and Sri Lanka.

Thirty-five more species have been recognised and the lists of species of many countries have been lengthened. Several species are here added for the first time to the lists of the following countries: Switzerland, 3 species [*Stylopauropus neglectus* Remy, *Acopauropus consobrinus* Remy, *Trachypauropus cordatus* (Scheller)]; Greece, 3 species (*Allopauropus helophorus* Remy, *Brachypauropus superbus* Hansen, *Acopauropus attemsi* Hasenhütl); Slovenia, 2 species (*Pauropus bagnalli* Remy, *Stylopauropus limitaneus* Remy); the Maltese Islands, 3 species [*Allopauropus danicus* (Hansen), *A. gracilis* (Hansen), *A. helveticus* (Hansen)]; Turkey 4 species [*Acopauropus hastatus* (Attems), *A. tetrastichus* (Scheller), *Trachypauropus cordatus* (Scheller), *T. glomerioides* Tömösváry]; Réunion, 1 species (*Sphaeropauropus reunionensis* sp. n.); Sri Lanka, 2 species, (*Sphaeropauropus nepalensis* Scheller, *S. reunionensis* sp. n.); Malaysia, 1 species (*Allopauropus rastifer* Remy); Indonesia, 1 species [*Allopauropus danicus* (Hansen)]; Rwanda, 2 species (*Allopauropus afer* sp. n., *Samarangopus rwandaensis* sp. n.) and Argentina, 1 species (*Stylopauropoides subantarcticus* Scheller).

All the material, preserved in alcohol (with one single exception), is deposited in the collections of the Department of Arthropods and Entomology I, Natural History Museum of Geneva.

SYSTEMATICS

PAUROPODIDAE

Genus *Allopauropus* Silvestri, 1902
Subgenus *Allopauropus* s. str.

1. *Allopauropus* (*A.*) *brevisetus* Silvestri
Allopauropus brevisetus Silvestri, 1902: fasc. 95, no. 12.

Material examined. CROATIA, Velebit Mountains, at road between Karlobag and Gospi₃, on the Gospi₃ side of the pass, oak forest, sifting, Berlese extraction, 1 juv. 5[1], 2.X.1970 (Loc. Ju-70/1, leg. B. Hauser).
Total number. 1 specimen.

General distribution. The main range covers southern Europe from France to Romania, Bulgaria and Greece. Known also from Great Britain, Switzerland, Austria and the USA.

2. *Allopauropus (A.) danicus* (Hansen)

Pauropus danicus Hansen, 1902: p. 376-378, pl. III, fig. 4.

Material examined. MALTESE ISLANDS, Malta, Dingli, Buskett Forest, soil sample, 1 ad. 9(♀), 1 subad. 8(♀), 2.V.1976 (Leg. V. Aellen & P. Strinati).
GREECE, Peloponnesus, Achaia, Erymanthos Massif, above Kalusion, alt. 980 m, under *Abies cephalonica* and *Quercus coccifera*, soil sample, Berlese extraction, 2 ad. 9(♀), 19 subad. 8(8♂, 10♀,1 sex?), 4 juv. 6, 1 juv. 5, 1.V.1980 (Loc. Sam-80/18, leg. B. Hauser); Messenia, near the road Areopolis - Kalamata, before Pygi, alt. 230 m, under *Quercus coccifera*, near a small stream, soil sample, Berlese extraction, 1 ad. 9(♀), 4 subad. 8(1♂,3♀), 2 juv. 6, 2 juv. 5, 18.V.1981 (Loc. Art-81/15, leg. B. Hauser). - Attica, Mount Hymette, near Markopoulon, close to the cave "Vavrona 2", under *Pistacia lentiscus*, soil sample, Berlese extraction, alt. 30 m, 5 juv. 6, 1 juv. 5, 20.III.1982 (Loc. Att-82/26, leg. B. Hauser). - Southern Island Arc, Karpathos, Lastos Massif, near the road Aperi – Spoa, alt. 430 m, under *Pinus brutia*, soil sample, Berlese extraction, 1 ad. 9(♂), 2 subad. 8(♀), 1 juv. 6, 10.III.1979 (Loc. Kar-79/8b, leg. B. Hauser).
AUSTRIA, Innsbruck, Martinswand, needle litter under pines, soil sample, Berlese extraction, 15 ad. 9(10♂, 5♀), 3 subad. 8(1♂, 2♀), IV-V.1964 (Leg. K. Thaler); ibidem, 5 ad. 9(1♂, 4♀), 2 subad. 8(♂), 17.V.1969 (Loc. I-69/1, leg. B. Hauser) and 2 ad. 9(♂), 29.IV.1969 (Loc. I-69/5, leg. K. Thaler).
MOROCCO, Rif Atlas, El-Gouzat, alt. 1050 m, soil sample under evergreen oaks, Berlese extraction, 2 ad. 9(♂), 1 juv. 6, 3 juv. 5, 2.VI.1978 (Loc. Mar-78/12, leg. B. Hauser); Smila, alt. 630 m, soil sample under *Pinus radiata,* Berlese extraction, 1 subad. 8(♀), 2.VI.1978 (Loc. Mar-78/13, leg. B. Hauser).
INDONESIA, East Java, Baluran Game Reserve, dry forest, alt. 100 m, in lava soil, 2 juv. 6, 4.VII.1973 (Loc. As-73/3, leg. P. Schauenberg).
Total number. 83 specimens.

General distribution. A wide range species known from most countries in Europe, from North and East Africa, South Asia and the Americas.

Remarks. A. danicus is here reported for the first time from the Maltese Islands and Indonesia.

3. *Allopauropus (A.) maroccanus* Remy & Moyne

Allopauropus (A.) maroccanus Remy & Moyne, 1960: p. 73-76, fig. 1.

Material examined. MOROCCO, Moyen Atlas, Tazzeka District, Bab-Azhar, under cork oaks, soil sample, Berlese extraction, 7 ad. 9(6♂, 1♀), 2 subad. 8(♀), 3 juv. 5, 1.VI.1978 (Loc. Mar-78/9, leg. B. Hauser).
Total number. 12 specimens.

General distribution. Known only from Morocco and Sri Lanka.

Taxonomical remarks. After having been able to study specimens from the type series (Morocco, Midelt, alt. 1500 m), it is evident that the temporal organs of this

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[1] Abbreviations: ad. ..., subad. ... and juv. ... = an adult, a subadult or a juvenile specimen with the number of pairs of legs indicated.

species are provided with large posterior pistils of the shape illustrated by Scheller (1970) in the description of *A. (A.) prope maroccanus* from Sri Lanka (Southern Province, Hikkaduwa and Deniyaya). These specimens have to be referred to *A. (A.) maroccanus* Remy & Moyne. The specimens reported above from Bab-Azhar also correspond with Remy & Moyne's types.

4. *Allopauropus (A.) afer* sp. n.   Figs 1-13

Type material. **Holotype**: ad. 9($\female$), RWANDA, Rangiro, alt. 1800 m, sifting in forest, 6.VI-II.1973 (Loc. Rwa-73/8, leg. P.Werner). **Paratype**: 1 ad. 9($\male$), same locality and date (Leg. P. Werner).

Total number. 2 specimens.

Diagnosis. A. (A.) afer sp. n. has many characters in common with *A. (A.) jeannelli* Remy from Mount Elgon (Remy, 1935b) but is distinguished from it by the shape of the lobes and the appendages of the anal plate (lateral lobes somewhat curved and blunt in *A. (A.) afer* sp. n., straight and pointed in *A. (A.) jeanelli* Remy; posteromedian lobe large and linguiform, not short, triangular, pointed). *A. (A.) ruwenzoriensis* Remy from Mount Ruwenzori (Remy, 1960) is similar in the same way. Good distinguishing characters are e.g. the shape of the posterior part of the anal plate [linguiform in *A. (A.) afer* sp. n., cleft deeply in *A. (A.) ruwenzoriensis* Remy], the pubescence of the T_3 (distal part with branched hairs, not naked and annulate) and the shape of the antennal globulus (almost spherical with narrow stalk, not pear-shaped with thicker stalk). The new species may also have distant relationships with *A. (A.) simulator* Remy from south-western France (Remy, 1947a) because there are similarities in the general plan of the anal plate and the styli, but they are easy to distinguish (e.g. pygidial setae a_1 very short in *A. (A.) afer* sp. n., very long in *A. (A.) simulator* Remy; appendages of the anal plate long, stalked and foliform, not short and clavate without stalk).

Etymology. From Latin afer = African.

DESCRIPTION

Length. 0.90(0.92)[2] mm.

Head. Tergal setae subcylindrical, annulate, blunt. Relative lengths of setae, 1st row: $a_1 = 10$, $a_2 = 11$; 2nd row: $a_1 = 11$, $a_2 = 11(12)$, $a_3 = 10$; 3rd row: $a_1 = 13(14)$, $a_2 = ?(20)$; 4th row: $a_1 = 9(10)$, $a_2 = 19$, $a_3 = 27$, $a_4 = 18$; lateral group setae: $l_1 = 25$, $l_2 = ?$, $l_3 = ?$. The ratio a_1/a_1- a_1 in 1st row 0.8, in 2nd row 0.5, in 3rd row (0.9)1.1 and in 4th row 1.0. Temporal organs ovoid, in tergal view about as long as their shortest distance apart. Head cuticle glabrous.

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[2] Measurements taken from adult paratypes are given in brackets.

FIGS 1-13

Allopauropus (A.) afer sp. n., holotype, ad. 9($\female$). 1, head, median and right part, and right antenna, tergal view; 2, collum segment, median and left part, sternal view; 3, tergite VI, posteromedian and left posterior part; 4, T_3; 5, T_4; 6, seta on coxa of leg 9; 7, seta on trochanter of leg 9; 8, tarsus of leg 9; 9, left genital papilla, anterior view; 10, pygidium, median and left part, sternal view; 11, pygidial seta a_1; 12, pygidial seta a_2; 13, anal plate, lateral view. Pubescence only partly drawn in Fig. 8. Scale a: Figs 2-7, 9; b: Figs 1, 8, 10-13.
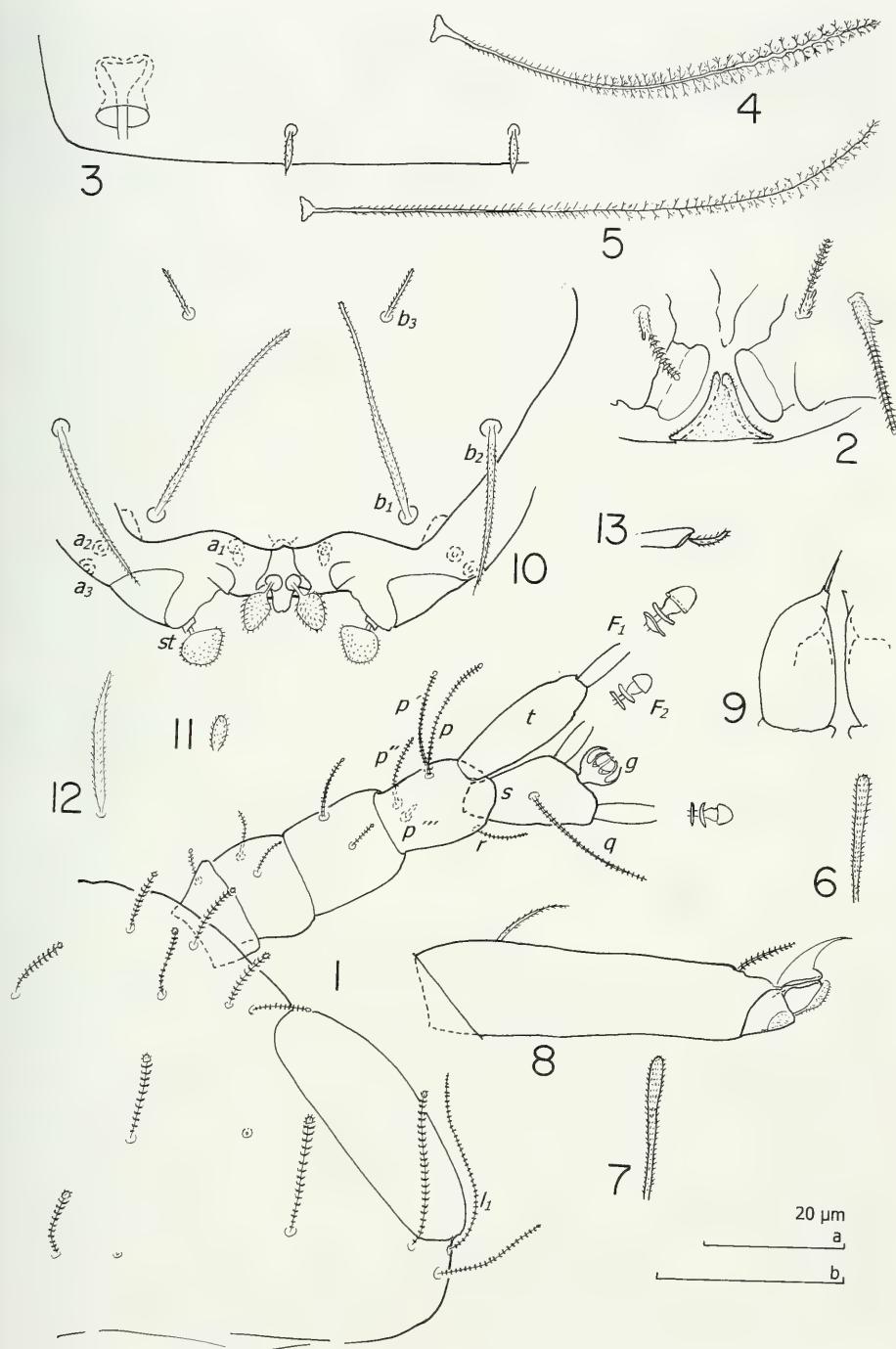
Antennae. Segment 4 with at least 5 cylindrical striate-annulate setae, *r* thinnest. Relative lengths of setae: $p = 100$, $p' = 82$, $p'' = 59$, $p''' = 14$, $r = 44$. Tergal seta *p* 0.8 of the length of tergal branch *t*. The latter fusiform, (2.8)3.2 times as long as its greatest diameter and 1.1 times as long as sternal branch *s* which is 1.9(2.2) times as long as its greatest diameter and with its anterodistal corner distinctly truncate. Seta *q* as tergal-anterior setae of 4th segment but somewhat thinner, as long as *s*. Relative lengths of flagella (with base segments included) and base segments: $F_1 = 100$, $bs_1 = (10)11$; $F_2 = (43)46$, $bs_2 = 8$; $F_3 = 115$, $bs_3 = 9(10)$. F_2 thinner than F_1 and F_3; F_1 4.1(4.3) times as long as *t*, F_2 and F_3 1.8 and 5.2 times as long as *s* respectively. Distal calyces hemispherical, glabrous, distal part of flagella axes widened only between calyx and first lamella. Globulus *g* 1.1 times as wide as long and with thin and very short, almost cylindrical stalk, ≈ 8 bracts and flattened capsule; diameter of *g* as long as greatest diameter of *t*. Antennae glabrous.

Trunk. Setae of collum segment furcate, primary branch cylindrical, annulate, blunt; secondary branch rudimentary, blunt, glabrous. Sublateral setae (1.6)1.7 times as long as submedian ones; process cleft anteriorly and with very short pubescence; appendages glabrous, subcylindrical, with wide caps.

Setae on tergites of about the same length, somewhat lanceolate and with oblique pubescence; 4+4 setae on tergite I, 6+6 on II-V and 4+2 on VI. Submedian posterior setae on tergite VI 0.2 of their interdistance and 1.6 times as long as pygidial setae a_1. Tergite I somewhat and tergites II-VI distinctly granular.

Bothriotricha. Relative lengths of bothriotricha: $T_1 = 100$, $T_2 = ?(81)$, $T_3 = (92)100$, $T_4 = 108$, $T_5 = 149$. Their axes simple, very thin in all but T_3. T_1, T_2 and T_4 similar to each other: short, erect, simple pubescence hairs proximally, somewhat longer outwards, on distal half branched and partly arranged in whorls. T_3 similar but with thicker axis. T_5 thin with short oblique pubescence of simple hairs.

Genital papillae (paratype). Glabrous, 1.8 times as long as their greatest diameter, inner margin straight, outer one evenly curved in distal half; seta 0.3 of the length of papilla.

Legs. Setae on coxa and trochanter of leg 9 simple, somewhat clavate, densely pubescent with hairs arranged in whorls; more anteriorly these setae are furcate with a rudimentary glabrous secondary branch. Tarsus of leg 9 very little tapering, (3.3)3.8 times as long as its greatest diameter. Proximal seta tapering, pointed, with short oblique pubescence, 0.2 of the length of tarsus and 1.2(1.5) times as long as distal seta which is subcylindrical and annulate. Cuticle of tarsus minutely granular.

Pygidium. Tergum. Posterior margin with deep posterior indentation between *st*, sides steep and bottom almost flat. Relative lengths of setae: $a_1 = 10$, $a_2 = (40)$, $a_3 = ?$, $st = 8$. These setae of very different shape: a_1 fusiform, blunt, a_2 lanceolate, both with short oblique pubescence; *st* subspherical bladders with short thin cylindrical stalk and short erect pubescence; a_1, a_2 and *st* converging. Distance a_1 - a_1 (2.4)2.5 times as long as a_1; distance a_1 - a_2 5 times longer than distance a_2 - a_3; distance *st* - *st* 4.2 times as long as *st* and (1.9)2.0 times as long as distance a_1 - a_1. Cuticle minutely pubescent.

Sternum. Posterior margin between b_1 with broad indentation and low median lobe with shallow posteromedian incision. Setae tapering, with short oblique pubescence. Relative lengths of setae ($a_1 = 10$): $b_1 = 62$, $b_2 = (46)48$, $b_3 = 16(20)$. The b_2

somewhat curved inwards. b_1 0.9 of their interdistance; b_2 1.4(1.5) times as long as distance b_1 - b_2; b_3 0.3(0.4) of distance b_3 - b_3.

Anal plate narrowest anteriorly, 1.3 times as long as broad, with lateral, blunt, posterolaterally directed horn-like processes; posterior part of plate extended into a linguiform lobe, from its base two diverging appendages protruding in posterolateral direction; appendages 0.7 of the length of plate, leaf-shaped, 1.4 times as long as wide, with thin cylindrical stalk and a dense oblique pubescence.

Subgenus *Decapauropus* Remy, 1957 (Remy, 1957a)

5. *Allopauropus (D.) aristatus* Remy
Allopauropus (D.) aristatus Remy, 1936a: p.19-22, figs 6-9.

Material examined. MOROCCO, Rif Atlas, El-Gouzat, alt. 1050 m, under evergreen oaks, soil sample, Berlese extraction, 8 ad. 9(♀), 41 juv. 6, 7 juv. 3, 2.VI.1978 (Loc. Mar-78/12, leg. B. Hauser).
Total number. 56 specimens.

General distribution. The species is known in Europe from France, Germany, Switzerland, Bulgaria, Spain, Yugoslavia, Greece; in Africa from Algeria, Morocco, Gambia, Madagascar; and in North America from the USA and Canada.

6. *Allopauropus (D.) corsicus* Remy
Allopauropus (D.) corsicus Remy, 1940: p. 48-50, figs 2-4.

Material examined. GREECE, Southern Island Arc, Crete, at the road Sitia - Iraklion, near Sfaka, small ravine, alt. 200 m, under *Quercus coccifera*, soil sample, Berlese extraction, 1 ad. 9(♀), 13.III.1979 (Loc. Kar-79/12a, leg. B. Hauser).
Total number. 1 specimen.

General distribution. Outside Greece (Scheller, 1977b) this species is known from France, Switzerland and Bulgaria.

7. *Allopauropus (D.) cuenoti* (Remy)
Decapauropus cuenoti Remy, 1931: p. 67-83, figs 1-12.

Material examined. GREECE, Elidia, S of Pirgos, forest near the Alfios river, alt. 30 m, under *Pinus* sp., soil sample, Berlese extraction, 1 juv. 6, 22.III.1982 (Loc. Att-82/32, leg. B.Hauser). - Central Greece, Peloponnesus, Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, soil samples, Berlese extraction, under date palm, 1 juv. 5, and under *Eucalyptus*, 1 juv. 6, 23.III.1982 (Loc. Att-82/37 and Att-82/39 respectively, leg. B. Hauser); at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, under *Abies cephalonica* and *Pinus* sp., soil sample, Berlese extraction, 3 ad. 9(♀), 25.III.1982 (Loc. Att-82/48, leg. B. Hauser). – Attica, Keratea, before the northern entrance of road, alt 160 m, under fig tree, 2 ad. 9(♀), 21.III.1982 (Loc. Att-82/30, leg. B. Hauser). – Aegean Islands, Ikaria, near the road Plumarion -Monokampion, alt. 420 m, high water level deposits, Berlese extraction, 1 juv. 5, 24.IV.1980 (Loc. Sam-80/6, leg. B. Hauser). - Samos, near Kosmathei, close to the entrance of the cave "Tsitse Tripa", alt. 510 m, old pine stumps, Berlese extraction, 2 ad. 9(♀), 5 subad. 8(♀), 4 juv. 6, 4 juv. 5, 25.IV.1980 (Loc. Sam-80/11, leg. B. Hauser).
MOROCCO, Grand Atlas, "Ifri-El-Kaid", moist guano sample from the beginning part of the cave, Berlese extraction, 1 juv. 6, 5.VI.1978 (Loc. Mar-78/25, leg. P. Strinati).
Total number. 25 specimens.

General distribution. Most European countries, North Africa, Madeira, the Canary Islands, Réunion and California.

8. *Allopauropus* (*D.*) *furcula* Silvestri

Allopauropus furcula Silvestri, 1902: fasc. 95, no. 7.

Material examined. GREECE, Elidia, S of Pirgos, forest near the Alfios river, alt. 30 m, under *Quercus pubescens*, soil sample, Berlese extraction, 1 ad. 9(♀), 22.III.1982 (Loc. Att-82/33, leg. B.Hauser). – Peloponnesus, Laconia, Talanta, at the road Neapolis – Monemvasia, alt. 210 m, under *Quercus coccifera*, soil sample, Berlese extraction, 3 ad. 9(1♂, 2♀), 4 subad. 8(1♂, 3♀), 3 juv. 6, 24.III.1982 (Loc. Att-82/45, leg. B. Hauser). - Messenia, at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, soil sample under *Abies cephalonica* and *Pinus* sp., Berlese extraction, 1 ad. 9(♀), 25.III.1982 (Loc. Att-82/48, leg. B. Hauser).

Total number. 12 specimens.

General distribution. Known from South Europe, Madeira and the Canary Islands.

9. *Allopauropus* (*D.*) *gracilis* (Hansen)

Pauropus gracilis Hansen, 1902: p. 395-397, pl. V, fig. 3.

Material examined. MALTESE ISLANDS, Malta, Dingli, Buskett Forest, soil sample, 1 ad. 9(♂), 2.V.1976 (Leg. V. Aellen & P. Strinati).

GREECE, Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, under *Araucaria*, soil sample, Berlese extraction, 5 subad. 8(♀), 1 juv. 6, 2 juv. 5, 23.III.1982 (Loc. Att-82/38, leg. B. Hauser) and under *Eucalyptus*, soil sample, Berlese extraction, 1 juv. 5, 23.III.1982 (Loc. Att-82/39, leg. B. Hauser) and under laurel, 2 ad. 9 (♂, ♀), 23. III.1982 (Loc. Att-82/40, leg. B.Hauser); at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, soil sample under *Abies cephalonica* and *Pinus* sp., Berlese extraction, 1 ad. 9(♀), 25.III.1982 (Loc. Att-82/48, leg. B. Hauser); near the road Areopolis - Kalamata, before Pygi, alt. 230 m, under *Quercus coccifera*, near a small stream, soil sample, Berlese extraction, 46 ad. 9(4♂, 42♀), 32 subad. 8(1♂, 30♀, 1 sex?), 27 juv. 6, 6 juv. 5, 1 juv. 3, 18.V.1981 (Loc. Art-81/15, leg. B. Hauser); ibidem, near Aghios Nikon, alt. 290 m, under *Quercus macrolepis,* 1 ad. 9(♂), 1 subad. 8(♀), 18.V.1981 (Loc. Art-81/13, leg. B. Hauser). - Arcadia, near the road Kandila - Skotini (Nemea), alt. 920 m, under *Quercus coccifera*, soil sample, Berlese extraction, 2 juv. 6, 17.V.1981 (Loc. Art-81/11, leg. B. Hauser). - Laconia, Taigetos Massif, alt. 960 m, soil sample, Berlese extraction, 12 ad. 9(2♂, 9♀, 1 sex?), 4 subad. 8(♀), 13 juv. 6, 20.V.1981 (Loc. Art-81/18, leg. B. Hauser). - Achaia, near Patras, Panachaikon Massif, Kastritsion, near the road behind the village, alt. 590 m, soil sample from under a log at the foot of a large plane tree, 1 ad. 9(♂), 22.IV.1980 (Loc. Sam-80/3, leg. B. Hauser); Erymanthos Massif, above Kalusion, alt. 980 m, under *Abies cephalonica* and *Quercus coccifera*, soil sample, Berlese extraction, 1 ad. 9(♂), 1.V.1980 (Loc. Sam-80/18, leg. B. Hauser). – Attica, near Megara, Kaki Skala, above the motorway at 48 km sign of the old road, under *Pistacia terebinthus*, soil sample, Berlese extraction, 1 subad. 8(♀), 21.IV.1980 (Loc. Sam-80/2, leg. B. Hauser). – Aegean Islands, Ikaria, near the road Plumarion - Monokampion, alt. 420 m, high water level deposits, Berlese extraction, 2 ad. 9(♀), 1 juv. 6, 24.IV.1980 (Loc. Sam-80/6, leg. B.Hauser). Samos, near Kosmathei, close to the entrance of the cave "Tsitse Tripa", alt. 510 m, old pine stumps, Berlese extraction, 1 subad. 8(♀), 3 juv. 6, 1 juv. 5, 2 juv. 3, 25.IV.1980 (Loc. Sam-80/11, leg. B. Hauser).

Total number. 171 specimens.

General distribution. A. *gracilis* seems to have a (sub)cosmopolitan range. It is one of the species most often met with in Europe but has also been reported from Africa, South Asia and the Americas.

Remarks. It is here reported for the first time from the Maltese Islands.

10. *Allopauropus* (*D.*) *helveticus* (Hansen)

Pauropus helveticus Hansen, 1902: p. 390-392, pl. IV, fig. 5.

Material examined. MALTESE ISLANDS, Malta, Dingli, Buskett Forest, soil sample, 1 subad. 8(♀), 2.V.1976 (Leg. V. Aellen & P. Strinati).

GREECE, Peloponnesus, Arcadia, Panachaikon Massif, near the road Kastritsion - Patras, alt. 260 m, under *Cupressus sempervirens*, soil sample, Berlese extraction, 2 juv. 6, 16.III.1982 (Loc. Att-82/5, leg. B. Hauser). - Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, under *Araucaria*, soil samples, Berlese extraction, 1 subad. 8(♀), 23.III.1982 (Loc. Att-82/38, leg. B. Hauser) and under laurel, 1 juv. 6, 23.III.1982 (Loc. Att-82/40, leg. B. Hauser). – Attica, near Loutropirgos, above the motorway Elefsis – Megara, 1-2 km behind the entrance to the high-way, alt. 90 m, under *Pinus halepensis*, Berlese extraction, 1 juv. 6, 15.III.1982 (Loc. Att-82/1, leg. B. Hauser). – Central Greece, Acarnania, near Gavrolimni, S of the road, alt. 170 m, under *Pistacia lentiscus*, soil sample, Berlese extraction, 1 ad. 9(♂), 17.III.1982 (Loc. Att-82/13, leg. B. Hauser).

SWITZERLAND, Vaud, the cave Grande Rolat, Berlese extraction, 1 juv. 6 mounted on slide, 26.VIII.1981 (Leg. P. Strinati, V. Aellen & C. Besuchet).

Total number. 8 specimens.

General distribution. The species may be Holarctic. It has been collected in most European countries, North Africa, the Azores and North America.

Remarks. A. helveticus is here reported for the first time from the Maltese Islands.

11. *Allopauropus (D.) helophorus* Remy
Allopauropus helophorus Remy, 1936b: p. 132-133, fig. 1.

Material examined. GREECE, Peloponnesus, Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, under *Eucalyptus*, soil sample, Berlese extraction, 1 juv. 6, 23.III.1982 (Loc. Att-82/39, leg. B. Hauser).

Total number. 1 specimen.

General distribution. The known range covers an area from Belgium and northern France in the northwest to Bosnia, Serbia and Romania in the southeast. The locality reported above, the first one from Greece, extends the range considerably in southeastern direction.

12. *Allopauropus (D.) multiplex* Remy
Allopauropus (A.) multiplex Remy, 1936c: p. 75-76 and 1936d: p. 315-316, fig. 3.

Material examined. GREECE, Aegean Islands, Samos, near Kosmathei, close to the entrance of the cave "Tsitse Tripa", alt. 510 m, old pine stumps, Berlese extraction, 1 subad. 8(♀), 1 juv. 3, 25.IV.1980 (Loc. Sam-80/11, leg. B. Hauser).

SWITZERLAND, Basle-Land, western Sundgau, near small stream Dorrenbach, under *Heracleum* and *Dactylis*, moist loess, 1 juv. 6, 16.VIII.1942 (Loc. Ae 254/g, leg. H. Gisin).

Total number. 3 specimens.

General distribution. A. (A.) multiplex is known from the Western Palaearctic Region only and occurs there from Sweden in the north to Morocco in the south, from Great Britain in the west to Greece in the east.

13. *Allopauropus (D.) pectinatus* (Hansen)
Pauropus pectinatus Hansen, 1902: p. 388-390, pl. IV, fig. 4.

Material examined. GREECE, Peloponnesus, Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, under *Araucaria*, soil sample, Berlese extraction, 1 juv. 6, 23.III.1982 (Loc. Att-82/38, leg. B. Hauser).

Total number. 1 specimen.

General distribution. A. (D.) pectinatus is a West Palaearctic species known from France and Spain in the west to Greece in the east, and also from Morocco and Algeria.

14. *Allopauropus* (*D.*) *productus* Silvestri

Allopauropus productus Silvestri, 1902: Fasc. 95, no. 9.

Material examined. GREECE, Peloponnesus, Laconia, Talanta, at the road Neapolis - Monemvasia, alt. 210 m, under St. John's bread tree, soil sample, Berlese extraction, 1 ad. 9(♀), 12 juv. 6, 24.III.1982 (Loc. Att-82/46, leg. B. Hauser). - Messenia, at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, under *Abies cephalonica* and *Pinus* sp., soil sample, Berlese extraction, 1 ad. 9(♀), 25.III.1982 (Loc. Att-82/48, leg. B. Hauser).

MOROCCO, Rif Atlas, El-Gouzat, alt. 1050 m, under evergreen oaks, soil sample, Berlese extraction, 1 juv. 6, 2.VI.1978 (Loc. Mar-78/12, leg. B. Hauser).

Total number. 15 specimens.

General distribution. A probably Holarctic species with its main distribution around the Mediterranean.

15. *Allopauropus* (*D.*) *rastifer* Remy

Allopauropus rastifer Remy, 1948: p. 573-574.

Material examined. MALAYSIA, Teman Negara National Park, alt. 240 m, lowland rain forest, soil sample, Berlese extraction, 1 ad. 9(♀), 27.VI.1973 (Loc. As-73/1, leg. P. Schauenberg).

Total number. 1 specimen.

General distribution. A. rastifer is a rare species, only 13 specimens were earlier known from 7 sites in Kenya, Madagascar, Réunion, Pondichéry and Sri Lanka. The locality reported here, the first one from Malaysia, extends the range of this species to Southeast Asia.

Taxonomical remarks. The species was described from a single female from Kenya (Remy, 1948). In the specimen reported by Remy (1956b) from Madagascar (sub nomine *A. rastrifer* Remy) the setae a_3 of the pygidial tergum are proportionally longer than in the type specimen, the posterior margin of the pygidial tergum is different in shape and the anal plate is probably so too. Similar deviations from the original description can be observed in the specimen from Réunion (Remy, 1956c). The anal plate is there proportionately long, its lateral appendages short and the pygidial tergum has a posteromedian semicircular lobe not mentioned by Remy in his description of the species.

In the Malaysian specimen reported here, the temporal organs are proportionately long and the antennal globulus *g* more ovoid than in the type specimen. Moreover are the coxal setae of leg 9 simple.

Observations on the specimens referred to *A. rastifer* indicate that the species might not be monotaxic.

16. *Allopauropus* (*D.*) *vulgaris* (Hansen)

Pauropus vulgaris Hansen, 1902: p. 392-395, pl. V, fig. 2.

Material examined. GREECE, Peloponnesus, Messenia, at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, under *Abies cephalonica* and *Pinus* sp., soil sample, Berlese extraction, 1 juv. 6, 25.III.1982 (Loc. Att-82/48, leg. B.Hauser). – Aegean Islands, Ikaria, near the road Plumarion - Monokampion, alt. 420 m, high water level deposits, Berlese extraction, 1 ad. 9(♀), 1 juv. 5, 24.IV.1980 (Loc. Sam-80/6, leg. B. Hauser).

Total number. 3 specimens.

General distribution. The species is widely distributed in Europe and has also been collected in Africa, Sri Lanka and North America.

17. *Allopauropus (D.) zaianus* Remy
Allopauropus zaianus Remy, 1952: p. 154-155, fig. 4.

Material examined. MOROCCO, Rif Atlas, El-Gouzat, alt. 1050 m, under evergreen oaks, soil sample, Berlese extraction, 1 ad. 9(♂), 2.VI.1978 (Loc. Mar-78/12, leg. B. Hauser).
Total number. 1 specimen.

General distribution. Known only from the southwestern Palaearctic: Portugal, Spain, Morocco and Algeria.

Genus *Pauropus* Lubbock, 1867

18. *Pauropus bagnalli* Remy
Pauropus Bagnalli Remy, 1935a: p. 1-2.

Material examined. SLOVENIA, Julian Alps, Triglav, on Tominskova trail, near Aljažev dom, alt. 1070 m, beech forest, under stone, 1 ad. 9(♀), 26.VIII.1967 (Loc. Tg-67/8, leg. B. Hauser).
Total number. 1 specimen.

General distribution. Previously known from France, Germany, Austria and the Slovak Republic. It is here reported for the first time from Slovenia.

19. *Pauropus huxleyi* Lubbock
Pauropus huxleyi Lubbock, 1867: p. 182-185, pl. 10, figs 1-19.

Material examined. GREECE, Elidia, S of Pirgos, forest near the Alfios river, alt. 30 m, under *Pinus* sp., soil sample, Berlese extraction, 5 ad. 9(1♂, 4♀), 9 subad. 8(2♂, 5♀, 2 sex?), 6 juv. 6, 6 juv. 5, 22.II.1982 (Loc. Att-82/32, leg. B.Hauser). – Peloponnesus, Laconia, Taigetos Massif, alt. 960 m, soil sample, Berlese extraction, 1 ad. 9(♀), 20.V.1981 (Loc. Art-81/18, leg. B. Hauser).
Total number. 27 specimens.

General distribution. *P. huxleyi*, in the sense of Lubbock, has been mentioned from many European countries, from North America and New Zealand and may have a wide range. However, it has often been confused with *P. lanceolatus* Remy, and at present it is impossible to delimit its range.

20. *Pauropus numidus* Remy
Pauropus numidus Remy, 1947b: p. 66-68, fig.1.

Material examined. MOROCCO, Moyen Atlas, Tazzeka District, Bab-Azhar, under cork oaks, soil sample, Berlese extraction, 2 juv. 6, 1.VI.1978 (Loc. Mar-78/9, leg. B. Hauser).
Total number. 2 specimens.

General distribution. The species is known from Spain and from a dubious record from Austria; outside Europe from Morocco, Algeria and the Canary Islands.

Genus *Stylopauropoides* Remy, 1956

21. *Stylopauropoides subantarcticus* Scheller
Stylopauropoides subantarcticus Scheller, 1974a: p. 62-65, fig. 2.

Material examined. ARGENTINA, Patagonia, W Ushuaia, Monte Susana, south slope, alt. c. 300 m, in litter of a *Nothofagus pumilis-betuloides* forest, Berlese extraction, 1 ad. 9(♂), 26.III.1975 (Loc. Am-75/3, leg. E. Horak).

Total number. 1 specimen.

General distribution. The species is here reported for the first time from Argentina. It was previously known only from one of the Crozet Islands in the French Subantarctic Territory. Its occurrence in southernmost Patagonia may indicate that the species is more or less widespread.

Genus *Stylopauropus* Cook, 1896

Subgenus *Stylopauropus* s. str.

22. *Stylopauropus (S.) neglectus* Remy

Stylopauropus (S.) neglectus Remy, 1962: p. 80-81, fig. 2.

Material examined. SWITZERLAND, Ticino, Grotta del Mago, alt. 350 m, 1 ad. 9(♀), 1 subad. 8(♀), 24.VI.1975 (Loc. Ju-75/15, leg. B. Hauser).

Total number. 2 specimens.

General distribution. *S. neglectus* was previously known from France, Austria and Italy.

Remarks. The species is here reported for the first time from Switzerland.

23. *Stylopauropus (S.) pedunculatus* (Lubbock)

Pauropus pedunculatus Lubbock, 1867: p. 185, pl. 10, fig. 20.

Material examined. SLOVENIA, Sneznik, alt. 1500 m, beech forest, under stones, 1 ad. 9(♀), 11.IX.1969 (Loc. Ju-69/32, leg. V. Mahnert); ibidem, alt. ca. 1100 m, 1 ad. 9(♂), 11.IX.1969 (Loc. Ju-69/33, leg. V. Mahnert). Between Godovic and Crni Vrh, beech forest, 2 ad. 9(♂), 1 stad.?, 12.IX.1969 (Loc. Ju-69/35, leg. V. Mahnert).

GREECE, Peloponnesus, Achaia, Erymanthos Massif, above Kalusion, alt. 980 m, under *Abies cephalonica* and *Quercus coccifera*, soil sample, Berlese extraction, 1 ad. 9(♀), 1.V.1980 (Loc. Sam-80/18, leg. B. Hauser). - Messenia, near the road Areopolis -Kalamata, before Pygi, near a small stream, alt. 230 m, under *Quercus coccifera*, soil sample, Berlese extraction, 1 ad. 9(♀), 3 subad. 8(1♂, 2♀), 1 juv. 6, 18.V.1981 (Loc. Art-81/15, leg. B. Hauser). - Arcadia, at a monastery near Kandila, alt. 870 m, 1 subad. 8(sex?), 16.V.1981 (Loc. Art-81/6, leg. B. Hauser). - Laconia, Taigetos Massif, alt. 960 m, under *Abies cephalonica*, soil sample, Berlese extraction, 6 ad. 9(♀), 9 subad. 8(8♀, 1 sex?), 7 juv. 6, 6 juv. 5, 2 juv. 3, 20.V.1981 (Loc. Art-81/18, leg. B. Hauser). – Messenia, Kalamata District, near Messini, Analipsis, alt. 20 m, under laurel, 2 subad. 8(♀), 1 juv. 6, 23.III.1982 (Loc. Att-82/40, leg. B. Hauser). - Messenia, at the road Sparta - Kalamata, on the Kalamata side of the pass, alt. 1000 m, under *Abies cephalonica* and *Pinus* sp., soil sample, Berlese extraction, 1 ad. 9(♀), 25.III.1982 (Loc. Att-82/48, leg. B. Hauser). - Corinth, near the road Klenia - Aghionorion, alt. 640 m, in the cave "Tripa tou Kalivaki", 1 ad. 9(♀), 1 subad. 8(♀), 13.V.1981 (Loc. Art-81/1, leg. B. Hauser). - Attica, Keratea, before the northern entrance of the road, alt. 160 m, under fig tree, 18 ad. 9(7♂, 11♀), 39 subad 8(12♂, 25♀, 2 sex?), 29 juv. 6, 19 juv. 5, 1 stad.?, 21.III.1982 (Loc. Att-82/30, leg. B. Hauser). - Aegean Islands, Ikaria, near the road Plumarion - Monokampion, alt. 420 m, sample from old stump of *Platanus orientalis*, Berlese extraction, 1 juv. 6, 24.IV.1980 (Loc. Sam-80/7, leg. B. Hauser). Samos, near Kosmathei, the cave "Kako Perato" near the monastery Kimisos Theotoki, alt. 580 m, 1 juv. 6, 25.IV.1980 (Loc. Sam-80/9, leg. B. Hauser). Samos, near Kosmathei, in the cave "Tsitse Tripa", alt. 510 m, 1 ad. 9(♀), 25.IV.1980 (Loc. Sam-80/10, leg. B. Hauser).

Total number. 157 specimens.

General distribution. *S. pedunculatus* occurs in Europe in many countries from Sweden in the north to Spain and Greece in the south. Outside Europe it is known from Morocco, the Canary Islands, and from the USA, Canada and Australia.

Subgenus *Donzelotauropus* Remy, 1957 (Remy, 1957a)

24. *Stylopauropus (D.) limitaneus* Remy
Stylopauropus (D.) limitaneus Remy, 1962: p. 76-78, fig 2.

Material examined. SLOVENIA, between Godovic and Crni Vrh, alt. ca 600 m, beech forest, 2 ad. 9(♀), 12.IX.1969 (Loc. Ju-69/35, leg. V. Mahnert). Julian Alps, Triglav, on Tominskova trail, near Aljaæv dom, alt. 1070 m, beech forest, under stone, 1 ad. 9(♀), 26.VIII.1967 (Loc. Tg-67/8, leg. B. Hauser).
Total number. 3 specimens.

General distribution. *S. limitaneus* is a rare species known from a few localities only: one in Austria, some in Romania, one in Italy and one in the USA. It is here reported from Slovenia for the first time.

Genus *Rabaudauropus* Remy, 1953

25. *Rabaudauropus cuspidatus* (Remy)
?Pauropus cuspidatus Remy, 1939: p. 12-15, figs 4-5.

Material examined. GREECE, Peloponnesus, Achaia, Panachaikon Massif, near the road Kastritsion-Patras, alt. 260 m, under *Cupressus sempervirens*, soil sample, Berlese extraction, 1 ad. 9(♂), 1 juv. 5, 6 juv. 3, 16.III.1982 (Loc. Att-82/5, leg. B. Hauser). - Laconia, Talanta, at the road Neapolis - Monemvasia, alt. 210 m, soil samples, Berlese extraction, 24.III.1982, under *Quercus coccifera*, 1 juv. 6 (Loc. Att-82/45, leg. B. Hauser) and under St. John's bread tree, 1 ad. 9(♀), 1 juv. 6, 1 juv. 5 (Loc. Att-82/46, loc. B. Hauser).
Total number. 12 specimens.

General distribution. *R. cuspidatus* has a Mediterranean range: South France, Italy, Bosnia, Romania, Greece and Morocco.

BRACHYPAUROPODIDAE

Genus *Brachypauropus* Latzel, 1884

26. *Brachypauropus superbus* Hansen
Brachypauropus superbus Hansen, 1902: p. 410-412, pl. VI, fig. 3.

Material examined. GREECE, Peloponnesus, Achaia, Erymanthos Massif, above Kalusion, alt. 980 m, under *Abies cephalonica* and *Quercus coccifera*, soil sample, Berlese extraction, 1 juv. 6, 1.V.1980 (Loc. Sam-80/18, leg. B. Hauser).
Total number. 1 specimen.

General distribution. The species has not often been met with, it is known from one locality in Poland, some in France, one in Romania, two in Spain and one in Italy. The locality reported above, the first one from Greece, extends the range considerably in southeast direction.

EURYPAUROPODIDAE

Subfamily **Eurypauropodinae**
Genus *Acopauropus* Cook, 1896

27. *Acopauropus attemsi* Hasenhütl   Fig. 14
Acopauropus attemsi Hasenhütl, 1987: p. 21-24, figs 1-3 on p. 43-47.

Material examined. Greece, Peloponnesus, at the road Sparta - Kalamata, alt. 1150 m, under *Pinus*, soil sample, Berlese extraction, 3 ad. 9(2♂,1♀), 20.V.1976 (Loc. The-76/32, leg. B. Hauser).

Total number. 3 specimens.

General distribution. A. attemsi is known from Carinthia and Styria in Austria only. The locality reported above, the first one from Greece, extends the range to southeast Europe.

Taxonomical remarks. Genital papillae with short pubescence, widest in the middle, inner and outer sides evenly curved, 1.4 times as long as their greatest diameter; length of seta 0.7 of the length of papilla.

28. *Acopauropus hastatus* (Attems)

Eurypauropus hastatus Attems, 1895: p.173-175, figs 15-18.

Material examined. Turkey, Istanbul, between Yalova and Orhangazi, 1 ad. 9(♀), 11.V.1976 (Loc. 1, leg. C. Besuchet & I. Löbl).

Switzerland, Ticino, Val Mara, alt. 800 m, under old tree stumps, 6 ad. 9(5♂,4♀), 4 subad. 8(1♂,3♀), 1 juv. 6, 18.IV.1976 (Leg. C. Besuchet).

Total number. 12 specimens.

General distribution. A. hastatus was previously known from the southern half of Europe only: Switzerland, Austria, Czech Republic, Italy, Slovenia and Romania. The known range of the species is here extended to west Turkey.

29. *Acopauropus consobrinus* (Remy)

Eurypauropus consobrinus Remy, 1937: p. 253-256, figs 1-5.

Material examined. France, Gard, above St. Jean du Gard, hazel, flotation, 1 ad. 9(♀), 26.X.1982, and Tornac, olivewood, 2 ad. 9(♀), 28.X.1982 (Leg. I.Löbl). Ibidem, Roquedur, flotation, 1 ad. 9(♂), 22.XI.1982 (Leg. C. Besuchet). - Pyrénées-Orientales, forest near the cave Pouade, 2 ad. 9(♂,♀), 12.IV.1977 (Leg. I. Löbl); ibidem, Parcigoule, 3 ad. 9(1♂, 2♀), 15.IV.1977 (Leg. I. Löbl); ibidem, 16 km W Tech, in ravine near the river Tech, 7 ad. 9(6♂,1♀), 15.IV.1977 (Leg. I. Löbl).

Switzerland, Ticino, Rancate, at foot of chestnut stump, 2 ad. 9(♀), 27.V.1982; Caprino, compost, 1 ad. 9(♀), 29.V.1982; Valle della Crotta, alt. 700 m, in litter, 1 ad. 9(♀), 21.V.1982 (Leg. C. Besuchet).

Total number. 20 specimens.

General distribution. This species has often been collected in South France but is rare outside. One locality each is known from Austria, Spain and Algeria. *A. consobrinus* is here reported for the first time from Switzerland.

30. *Acopauropus hispanicus* (Scheller)

Gravieripus hispanicus Scheller, 1974b: p. 626-630, figs 6-7.

Material examined. Spain, Gerona Prov., Col de Coubet, alt. 960 m, 22 ad. 9(13♂, 9♀), 19.VII.1975 (Leg. I. Löbl).

Total number. 22 specimens.

General distribution. The species was previously known only from the locality of the male holotype in Spain (Gerona Prov., near Olot, Uria).

31. *Acopauropus tetrastichus* Scheller

Acopauropus tetrastichus Scheller, 1981b: p. 167, 169-172, figs 4-5.

Material examined. TURKEY, above Zonguldak, alt. 500 m, 3 ad. 9(1♂, 2♀), 23.V.1976 (Loc. 35, leg. C. Besuchet & I. Löbl).

Total number. 3 specimens.

General distribution. A. tetrastichus was known only from one specimen from the type locality in the Georgian Republic in the Caucasus Mountains (Scheller, 1981b).

Remarks. The specimens studied here correspond in general very well with the type specimen, but the antennal globulus *g* is proportionately longer and the *g'* shorter, both the antennal branches are more slender and the distal part of the genital papillae are more distinctly cylindrical. The species is here reported for the first time from Turkey.

Genus *Trachypauropus* Tömösváry, 1882

32. *Trachypauropus cordatus* (Scheller)   Figs 15-18

Gravieripus cordatus Scheller, 1974b: p. 617-622, figs 1-2.

Material examined. ITALY, near Siena, Montalbuccio, 3 ad. 9(♀), 1 subad. 8(♀), 1 juv. 6, XI.1974 (Leg. R. Dallai).

GREECE, Elidia, S of Pirgos, forest near the Alfios river, alt. 30 m, soil samples, Berlese extraction, under *Pinus* sp., 13 ad. 9(6♂, 6♀, 1 sex?), 8 subad. 8 (4♂, 4♀), 1 juv. 6, 3 juv. 5, 3 juv. 3 (Loc. Att-82/32, leg. B. Hauser), and under *Quercus pubescens*, 1 subad. 8(♂), 1 juv. 6, 22.III.1982 (Loc. Att-82/33, leg. B. Hauser). - Peloponnesus, Messenia, near the road Areopolis - Kalamata, before Pygi, near a small stream, alt. 230 m, under *Quercus coccifera*, soil sample, Berlese extraction, 3 ad. 9(♀), 5 juv. 6, 1 juv. 5, 18.V.1981 (Loc. Art-81/15, leg. B. Hauser). – Aegean Islands, Ikaria, near the road Plumarion - Monokampion, alt. 420 m, Berlese extraction, sifting of high water level deposits near small river, 1 juv. 5, 24.IV.1980 (Loc. Sam-80/5b, leg. B. Hauser) and sample from old stump of *Platanus orientalis*, 1 subad. 8(♀), 24.IV.1980 (Loc. Sam-80/7, leg. B. Hauser). Samos, near Kosmathei, close to the entrance of the cave "Tsitse Tripa", alt. 510 m, old pine stump, Berlese extraction, 1 ad. 9(♂), 25.IV.1980 (Loc. Sam-80/11, leg. B. Hauser). – South Island Arc, Crete, at the road Sitia - Iraklion, near Sfaka, small ravine, alt. 200 m, under *Quercus coccifera*, soil sample, Berlese extraction, 2 ad. 9(♀), 13.III.1979 (Loc. Kar-79/12b, leg. B. Hauser).

TURKEY, 7 km E Yasilkent, Antakya, alt. 350-400 m, in litter, 1 ad. 9(♀), 4.V.1978 (Loc. 22, leg. C. Besuchet & I. Löbl).

SWITZERLAND, Geneva, Malval, in moss, 1 ad. 9(♀), 8.VII.1983, and Chancy, under old log, 1 ad. 9(♀), 13.VII.1983 (Leg. C. Besuchet).

Total number. 48 specimens.

General distribution. T. cordatus was known earlier from Spain, Italy and Greece, but the localities reported above from Switzerland and Turkey, the first ones from these countries, indicate a wider range both in the north and south-east.

Taxonomical remarks. No males were available when *T. cordatus* was described (Scheller, 1974b, 1977a) but the discovery of some, both adults and subadults, in the material from Greece makes it possible to describe the genital papillae of both stages. In adults they are glabrous, distinctly conical, 1.4-1.5 times as long as their greatest diameter, with the seta 0.8-0.9 of the length of papilla; in subadults they are also glabrous and without seta, either very small or larger, about half of the length of the papillae in the adults.
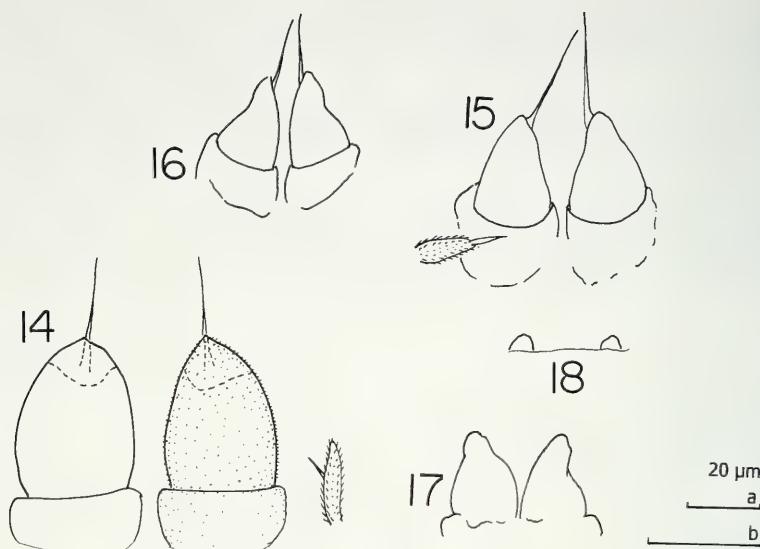
FIGS 14-18

Genital papillae. 14, *Acopauropus attemsi*, ad. 9; 15-18, *Trachypauropus cordatus*, 15-16 ad. 9 and 17-18 subad. 8. Pubescence only partly drawn in Fig. 14. Scale a: Figs 14-16; b: Figs 17-18.

33. *Trachypauropus glomerioides* Tömösváry

Trachypauropus glomerioides Tömösváry, 1882: p. 362-363, figs 4-8.

Material examined. TURKEY, above Zonguldak, alt. 500 m, 16 ad. 9(5♂, 11♀), 23.V.1976 (Loc. 35, leg. C. Besuchet & I. Löbl).

SWITZERLAND, Geneva, Bellerive, compost, 2 ad. 9(♀), 22.VI.1980, and Geneva, Frontenex, at foot of oak, 2 ad. 9(♀), 11.VI.1981 (Leg. C.Besuchet).

Total number. 20 specimens.

General distribution. *T. glomerioides* seems to have a Central European – East Mediterranean distribution from eastern France and Italy in the west to Romania and Turkey in the east. The species is here reported for the first time from Turkey.

34. *Trachypauropus latzeli* (Cook)

Eurypauropus latzeli Cook, 1896: p. 32.

Material examined. FRANCE, Drôme, Forêt de Saou, among dead leaves, 1 ad. 9(♀), 29.IX.1981 (Leg. C. Besuchet). - Haute-Savoie, Grand Salève, in moss, alt. 1350 m, 1 ad. 9(♀), 19.X.1980 (Leg. C. Besuchet).

SWITZERLAND, Basle, Diegten, in dead leaves, 3 ad. 9(♀), 28.IX.1975 and 3 ad. 9(2♂, 1♀), 26.IX.1976 (Leg. C. Besuchet). - Vaud, Onnens, old stump, 1 subad. 8(♀), 16.VI.1976 (Leg. C. Besuchet). - Geneva, Chancy, at the foot of old stump, 1 ad. 9(♂), 25.II.1976 (Leg. C. Besuchet); ibidem, Vers-Vaux, at the foot of old stump, 3 ad. 9(1♂, 2♀), 16.X.1976 (Leg. C. Besuchet).

Total number. 13 specimens.

General distribution. The species has not so often been collected but it seems to be widely distributed in the southern half of Europe.

Genus *Samarangopus* Verhoeff, 1934

35. *Samarangopus molestus* Remy   Figs 19-25
Samarangopus molestus Remy, 1959: p. 186-189, fig. 14.

    Material examined. MAURITIUS, Curepipe, Trou-aux-Cerfs, alt. 700 m, 1 ad. 9($\female$),
20.I.1975 (Loc. Mau-75/26, leg. P. Schauenberg).
    Total number. 1 specimen.
    Remarks. The species was previously known from three sites on Mauritius
(Remy, 1959). The specimen reported above agrees well with the description of the
type. However, some important details were not studied by Remy and the description
is emended in the following respects.

COMPLEMENTARY DESCRIPTION

    Antennae. Neither the antennal setae nor the branch *t* was drawn by Remy. The
main part of the antenna is shown in fig. 20. Base segments of flagella with short
oblique pubescence.
    Trunk. Tergites I-V each with several low elevations (Figs 19, 21) having the
largest type of cuticular protuberances.
    Bothriotricha. All bothriotricha but T_3 with very thin axes, glabrous most
proximally and outwards covered with erect minute pubescence. T_3 with distinct
pubescence (Fig. 22).
    Legs (Figs 23, 24). Setae on coxa and trochanter of all legs furcate. The one on
coxa of leg 9 with rudimentary, glabrous, pointed secondary branch, the one on
trochanter with subequal branches. More anteriorly these setae are similar to those of
the coxa of leg 9.
    Tarsi distinctly tapering, on leg 1 and 9 2.0 times longer than their greatest
diameter. Tarsi of leg 1 with one straight and thin seta, almost 0.3 of the length of
tarsus. Tarsi of leg 9 with two tergal setae, both strongly tapering, the distal one thickest
and distinctly curved; length of proximal seta 1/3 of the length of tarsus and 1.6 times
as long as distal seta. Length of the main claw 0.6 of the length of tarsus in leg 1 and
0.5 in leg 9.
    Pygidium (Fig. 25). *Tergum.* Posterior margin with shallow indentation between
st and short digitiform appendages behind a_3, about as long as a_2. Setae a_1, a_3 and *st*
tapering and pointed, a_1 and *st* also curved inwards, a_3 also diverging; a_2 straight, cylin-
drical, blunt and converging, all but *st* shortly pubescent. Index of tergal setae $a_1 = st$
$= 5$, $a_2 = 3$, $a_3 = 8$, $a_1 - a_1 = 10$, $a_2 - a_2 = 22$, $a_3 - a_3 = 32$, $st - st = 9$ µm; $st - st/a_1 - $
$a_1 = 0.9$, $a_1/a_1 - a_1 = 0.5$, $a_1/a_1 - a_2 = 0.8$, $a_1 - a_1/a_2 - a_3 = 1.0$; cuticle between a_2, a_3
and *st* minutely granular.
    Sternum. Posterior margin between b_1 with shallow indentation; setae thin, b_1
and b_2 tapering, pointed, minutely pubescent, b_3 cylindrical. Index of sternal setae: b_1
$= 25$, $b_2 = 20$, $b_3 = 10$, $b_1 - b_1 = 30$, $b_2 - b_2 = 48$, $b_3 - b_3 = 19$; $b_1/b_1 - b_1 = 0.8$, b_2/b_1-
$b_2 = 0.9$; $b_3/b_3 - b_3 = 0.5$.
    Anal plate 1.1 times as broad as long, anterior and posterior ends of the same
breadth; lateral margins with a pair of diverging, blunt, cylindrical branches, ≈ 0.7 of
the length of plate and curved inwards; posterior half of the plate divided longi-

tudinally by a narrow incision into two somewhat narrowing appendages, which are cut squarely at distal end; their ends with thornlike prolongation of inner margin and large bladders covered with a short but dense pubescence; bladders 3 times longer than wide, 0.8 of the length of plate.

36. *Samarangopus rwandaensis* sp. n. Figs 24-37

Type material. **Holotype:** ad. 9(♂), RWANDA, Rangiro, alt. 1800 m, sifting in forest, 26.VIII.1976 (Loc. Rwa-73/7, leg. P. Werner). **Paratype:** 1 ad. 9(♂), same locality as holotype, 10.VII.1973 (Loc. Rwa-73/7, leg. P. Werner).

Total number. 2 specimens.

Diagnosis. Samarangopus is probably rich in species because new finds almost always have resulted in descriptions of new species. Thus, as several new species remain to be discovered, every statement on the relationships of *S. rwandaensis* will be premature. However the structure of the tergites indicates that two New Caledonian species, *S. umbraculus* Scheller (Scheller, 1993) and *S. browni* Remy (Remy, 1957b), may be most closely related.

Etymology. A latinized adjective of the name Rwanda.

DESCRIPTION

Length. (1.05)1.10 mm.

Head. No vertex setae. Anterior part of temporal organs turned up without contact with the head cuticle.

Antennae. Chaetotaxy of segments 1-4: 2/2/2/3; no g'; setae thin, tapering, pointed, striate on segment 4, $p = 30$, $p' = 24(25)$, $p'' = (27)29$ µm; neither p''' nor u and r. Sternal branch subcylindrical but with distinct anterior truncation, anterior margin = (30)32, posterior margin = 45(50), Ø of base = 12, maximum Ø = (13)14 µm, q thin tapering pointed striate, l = (14)16 µm. Posterior margin/length of g (2.6)2.9, posterior margin/maximum Ø = 3.2(3.8), maximum Ø/Ø of base = (1.1)1.2. Tergal branch subcylindrical, l = 40(50), Ø of base = 8(9), maximum Ø = 9.5(12) µm; pore not discernible; length of t/maximum Ø = 4.2. Globulus g, l = 17, maximum Ø = 10 µm; length/maximum Ø = 1.7; number of bracts 12(13), their length = 7, capsule with flattened bottom, l = 3(-4), Ø = (5)6 µm. Relative lengths of flagella (with base segments included): $F_1 = 100$, $F_2 = 42$, $F_3 = (84)86$. Lengths of base segments, $bs_1 = (13)18$, $bs_2 = (12)13$, $bs_3 = (23)27$. F_1 (2.8) times as long as t, F_2 and F_3 1.4 and (2.7)2.8 times as long as s respectively. Antennae glabrous but the helmet-shaped calyces have all a very short pubescence.

Trunk. Collum segment hidden. Tergites with two main types of protuberances: 1. rod-shaped with transparent cup protruding in a single row from bulges on anterior and lateral margins of tergite I and from lateral margins of tergites II-VI. 2. round cushion-like structures (in tergal view) with a small opening on the top and a pattern inside similar to a cart wheel with several spokes, which are thickest near a central cavity; cushion-like structures evenly distributed over the tergites, except most anteriorly on tergites II-VI. Posterior margins of tergites I-V lined with a row of such cushion-like structures. On all tergites there is a complicated pattern of other cuticular structures: cavities with canals forming a radiating pattern at the bottom, canals
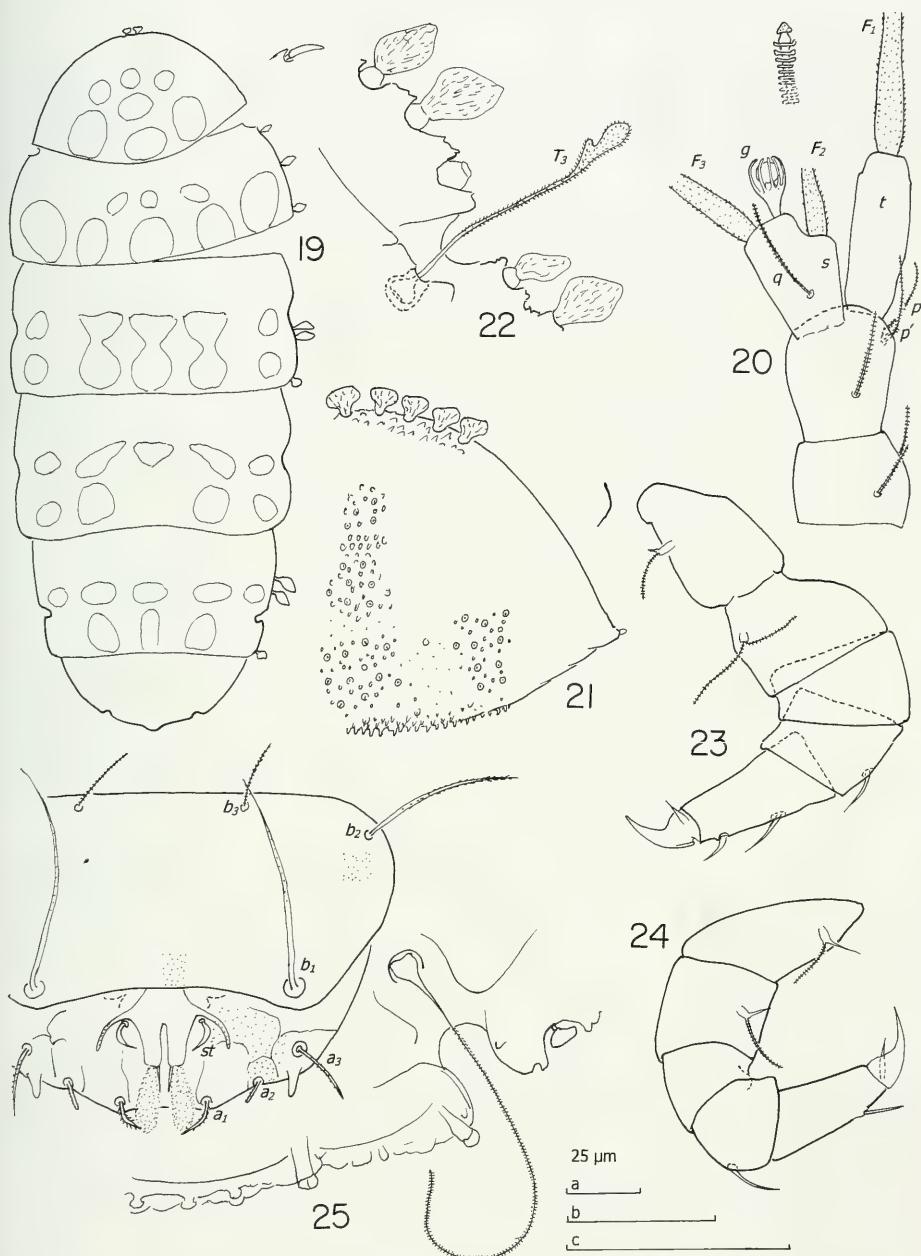
FIGS 19-25

Samarangopus molestus Remy. 19, body with low elevations, tergal view; 20, left antenna, sternal view; 21, tergite I, median and right part; 22, tergite IV, lateral side with T_3, sternal view; 23, leg 9; 24, leg 1; 25, pygidium and left posterolateral part of tergite VI, sternal view. Pubescence only partly drawn in Fig. 25. Scale a: Fig. 21; b: Figs 22-24; c: Figs 20,25.

connecting the cushion-like protuberances, and bare patches, the latter being few and indistinct.

Bothriotricha. All bothriotricha but T_3 with very thin axes, glabrous except for their distal parts which have a minute pubescence. T_3 with thicker axes, distal third increasing in width distally forming a clavate swelling with very short, almost erect pubescence.

Genital papillae. Glabrous, subcylindrical, with almost straight inner margin, (1.7)1.8 times as long as greatest diameter; seta 0.4 of length of papilla.

Legs. All legs 5-segmented. Setae on coxa and trochanter of leg 9 furcate, striate, bases pubescent; length of secondary branch 0.5 of primary one; more anteriorly setae with rudimentary pointed glabrous secondary branches. Tarsi tapering; those of leg 9 (2.6)2.8 times as long as their greatest diameter, with two tergal setae, both pointed and glabrous; length of proximal one 20, distal one 15 µm. Proximal setae 0.3(0.4) of the length of tarsus and 1.6 times as long as distal seta. Cuticle of tarsus with short pubescence. No proximal seta on tarsi of leg 1. All legs with large main claw and small setose anterior secondary claw; length of main claw 0.5 of the length of tarsus in both leg 1 and 9. Disciform appendage of leg 1 not available for study.

Pygidium. Tergum. Posterior margin rounded but with tergal indentation and distinctly pubescent sternal lobe between a_1, lobe with small, posteromedian subtriangular projection. Setae a_1, a_2 and a_3 diverging, with oblique pubescence, a_1 and a_2 clavate, the latter also curved inwards, a_3 cylindrical, blunt, diverging, st rudimentary, diverging, glabrous. Index of setae: $a_1 = 10$, $a_2 = 8(9)$, $a_3 = (17)18$, $st = 1$ µm. Distance $a_1 - a_1 = (11)12$, $a_2 - a_2 = 27(28)$, $a_3 - a_3 = 45(47)$, $a_1 - a_2 = (9)10$, $a_2 - a_3 = 11(12)$, $st - st = 17$ µm. Distance $a_1 - a_1$ (1.1)1.2 times as long as a_1, distance $a_1 - a_2$ (0.8)0.9 of distance $a_2 - a_3$; distance $st - st$ 17 times as long as st and 1.4 times as long as distance $a_1 - a_1$. Cuticle glabrous, except in front of a_1 and a_2.

Sternum. Posterior margin with broad indentation between b_1. Setae with distinct oblique pubescence; b_1 tapering, blunt, with very dense pubescence, b_2 fusiform, 6.2 times as long as its greatest diameter, pointed, b_3 tapering, pointed. Index of setae: $b_1 = (40)45$, $b_2 = 25(26)$, $b_3 = 14$ µm. Distance $b_1 - b_1 = 43(44)$, $b_2 - b_2 = 56(62)$, $b_3 - b_3 = (29)32$, $b_1 - b_2 = 43$, $b_2 - b_3 = 23(26)$ µm. Distance $b_1 - b_1$ 1.0(1.1) of the length of b_1, b_2 0.6 of distance $b_1 - b_2$, b_3 0.4 of distance $b_3 - b_3$.

Anal plate broadest anteriorly, (1.4)1.5 times as long as broad, lateral margins almost straight and with tapering diverging appendages, 0.6 of the length of plate, distal part of plate cleft by a V-shaped incision into two tapering branches; each branch truncate and provided with two appendages: an inner pointed, glabrous one, 0.4 of the length of the plate, and an outer bladder-shaped one with (0.6)0.8 of the length of plate. Plate glabrous, lateral appendages with strong oblique pubescence, bladder-shaped appendages with dense short pubescence.

Remarks. This is the first time the genus *Samarangopus* can be reported from continental Africa. It was earlier known from Madagascar and eastwards from the Oriental Region, as well as from two areas in Notogaea, New Caledonia (Scheller, 1993) and Papua New Guinea (Scheller, 1996).
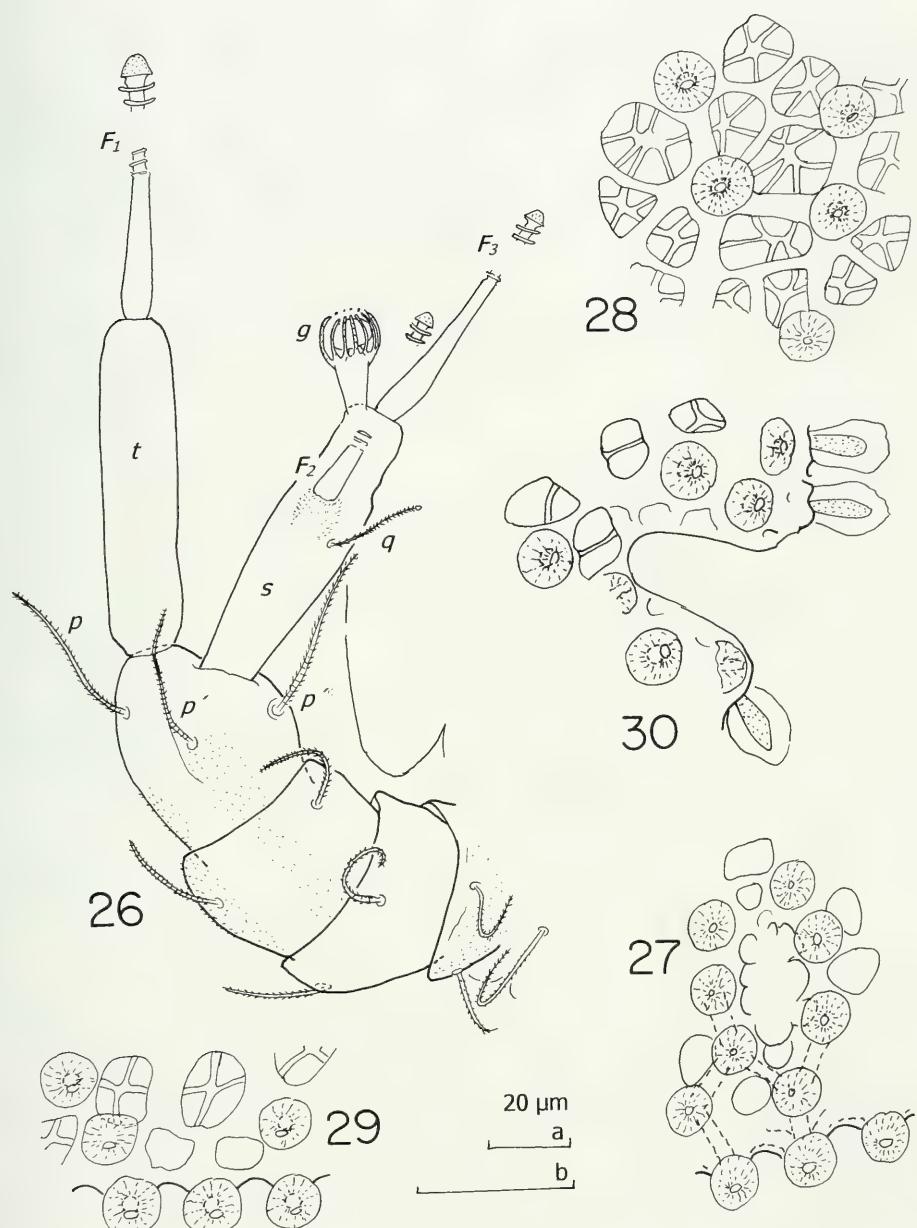
FIGS 26-30

Samarangopus rwandaensis sp. n., holotype ad. 9(δ). 26, left antenna, sternal view; 27, tergite II, bare patch surrounded by cavities in the cuticula and by cushion-like structures; canals between cushion-like structures drawn as dashed lines at the lower part of drawing; 28, tergite IV, anterior part; 29; tergite IV, posteromedian part; 30, tergite VI, lateral part with insertion pit of T_5, tergal view. Pubescence only partly drawn in Fig. 26. Scale a: Figs 27-30; b: Fig. 26.
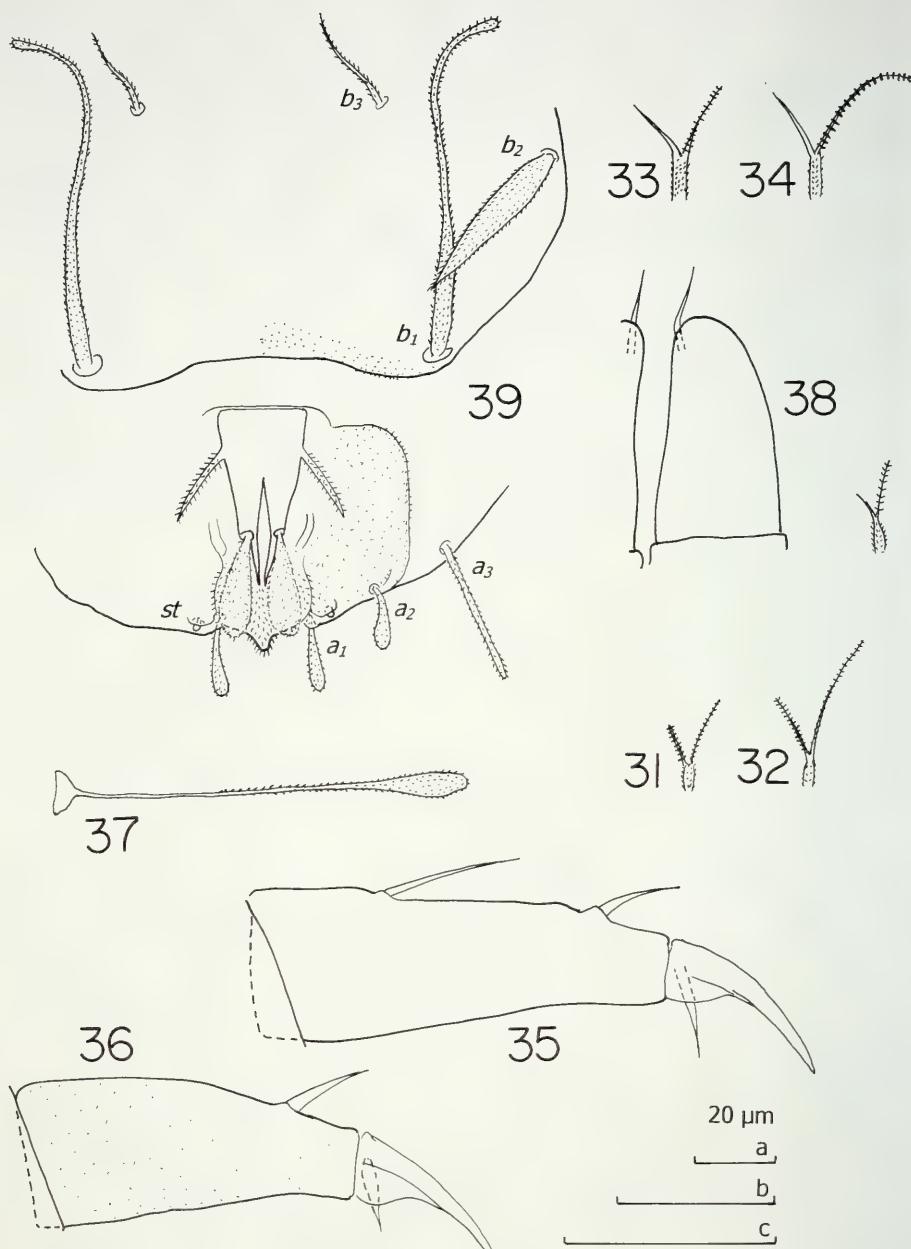
FIGS 31-39

Samarangopus rwandaensis sp. n., holotype ad. 9(♂). 31, seta on coxa of leg 9; 32, seta on trochanter of leg 9; 33. seta on coxa of leg 8; 34, seta on trochanter of leg 8; 35, tarsus of leg 9; 36, tarsus of leg 1; 37, *T₃*; 38, right genital papilla and seta on coxa of leg 2, anterior view; 39, pygidium, sternal view. Pubescence only partly drawn in Fig. 39. Scale a: Figs 35, 36, 38; b: Figs 31-34, 37; c: Fig. 39.

Subfamily **Sphaeropauropodinae**

Genus *Sphaeropauropus* Silvestri, 1930

37. *Sphaeropauropus nepalensis* Scheller

Sphaeropauropus nepalensis Scheller, 2000: p. 118-121, figs 71-86.

Material examined. SRI LANKA, Central Province, Hakgala, wooded ravine in the northeast, alt. 1700-1800 m, sifting, 1 ad. 9($\female$), 28.I.1970 (Loc. 30a, leg. C. Besuchet & I. Löbl).
Total number. 1 specimen.

General distribution. S. nepalensis is new to Sri Lanka. It was described from Nepal (Scheller, 2000) and is here reported for the first time outside the Himalaya.

Taxonomical remarks. The styli on the pygidial tergum of the specimen examined are thinner than in the material from Nepal.

38. *Sphaeropauropus reunionensis* sp. n.   Figs 40-51

Type material. **Holotype:** ad. 9($\female$), RÉUNION, St. Philippe, 14-15.I.1975 (Loc. Mau-75/60, leg. P.Schauenberg). **Paratype:** 1 subad. 8($\female$), same locality and date as holotype.
Other material. SRI LANKA, Central Province, Matale, wooded ravine, alt. 400 m, sifting, 1 ad. 9($\female$), 17.I.1970 (Loc. 7, leg. C. Besuchet & I. Löbl); Kandy, Udawattekele Sanctuary, primary forest, alt. 600 m, sifting, 1 ad. 9($\male$), 19.I.1970 (Loc. 11, leg. C. Besuchet & I. Löbl). - Uva Province, about 10 km N Monaragala, forest, sifting, 1 ad. 9($\male$), 13.II.1970 (Loc. 64, leg. C. Besuchet & I. Löbl).
Total number. 5 specimens.

Diagnosis. The species described here is well delimited from *S. malayus* Silvestri. Good distinguishing characters can be found in the shape of the antennal globulus *g*, the T_3, the claws and the tarsi and in the cuticular structures of the tergites.

Etymology. A latinized adjective of the name Réunion.

DESCRIPTION

Length. 0.92 mm.
Head. Setae hidden. Vertex: ve_1 rudimentary. Temporal organ, l = 60 µm.
Antennae. Cuticle of segments 1-4 almost glabrous, branches and flagellae glabrous, calyces small and glabrous. Chaetotaxy of segments 1-4: 2/2/2+g'/3. Setae cylindrical, annulate, *g*' small subhemispherical, segment 4, *p* = 42, *p*' = 35, *p*" = 15 µm. Sternal branch with distinct anterodistal truncation, anterior margin = 24, posterior margin = 32, Ø of base = 9, maximum Ø = 12.5, upper Ø = 10, *q* = 20 µm. Anterior margin/length of *g* = 1.5; anterior margin/length of *q* = 1.2; anterior margin/posterior margin = 0.6; anterior margin/maximum Ø = 2.0; maximum Ø/Ø of base = 1.4. Tergal branch *t* somewhat fusiform, length = 37, Ø of base = 5, maximum Ø = 10 µm, length of *t*/maximum Ø = 3.7. Globulus *g* somewhat curved, stalk conical, length of *g* = 16, maximum Ø = 9.5 µm; ≈ 10 bracts, their length = 7-8 µm; capsule somewhat flattened, length = 5, Ø = 5.5 µm. Relative lengths of flagella (with base segments included): F_1 = 100, F_2 = ?, F_3 = 102. Lengths of base segments: bs_1 = 19, bs_2 = 9, bs_3 = 17 µm. The F_1 2.9 times as long as *t*, F_3 3.4 times as long as *s*.
Trunk. Setae of collum segment hidden. Sternite process with narrow and rounded anterior end; appendages with low round caps, Ø = 25 µm.
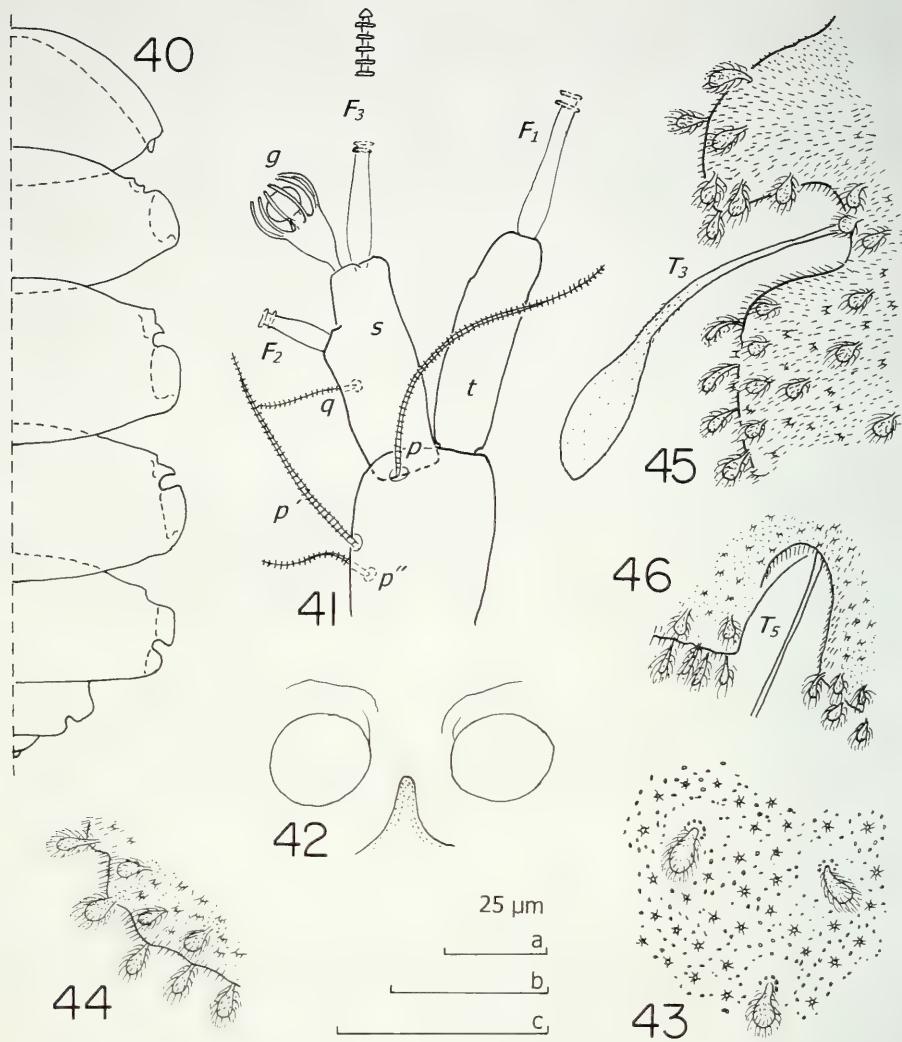
FIGS 40-46

Sphaeropauropus reunionensis sp. n., holotype 9(♀). 40, body, right half, tergal view; 41, left antenna, tergal view; 42, collum segment, sternal view (setae not drawn); 43, tergite I, central part; 44, tergite II, left posterolateral corner; 45, left part of tergite IV with T_3, tergal view; 46, left part of tergite VI with base of T_5, sternal view. Scale a: Fig. 42; b: Figs 41, 46; c: Figs 43-45.

Tergal sides of tergites with tuft-like setae, those on anterior part of tergite I broadly clavate with thick stalks. Cuticle between tuft-like setae with short rows of granules and very small protuberances covered with great many inward-curved oblique pubescence hairs. Tuft-like setae less clavate on lateral margins, sometimes with almost cylindrical stalks; laterosternal setae often more elongate, sometimes even
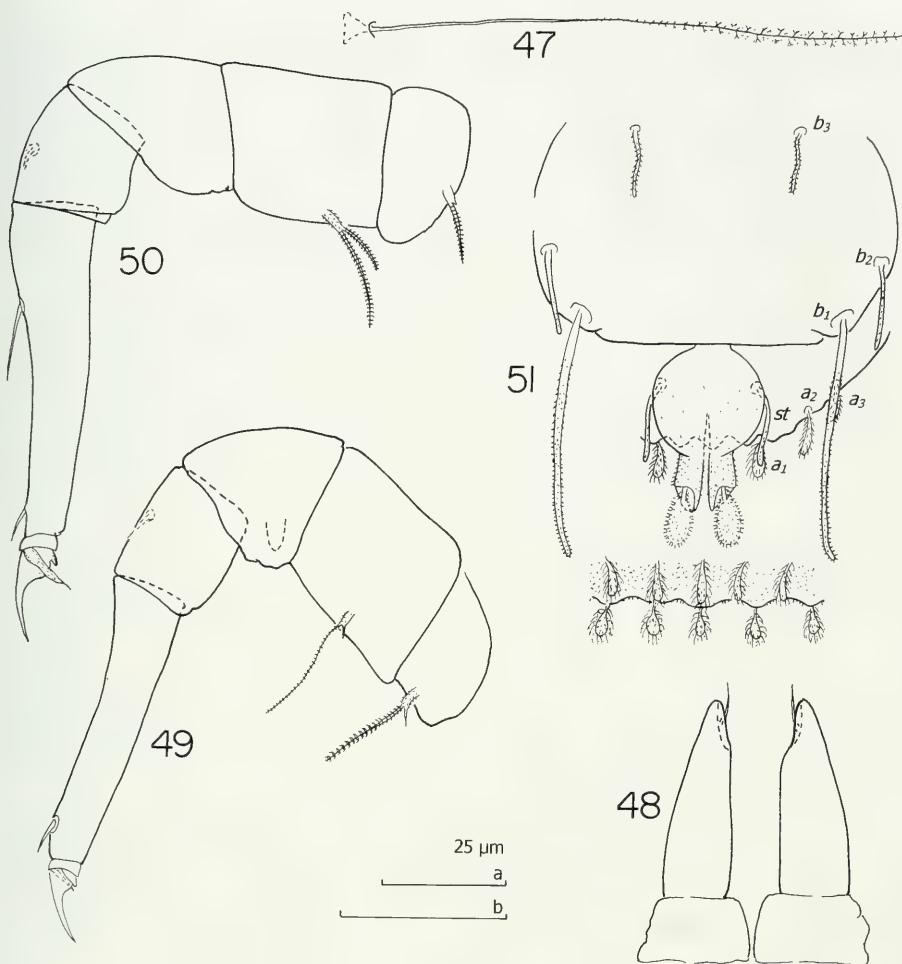
FIGS 47-51

Sphaeropauropus reunionensis sp. n., 47, 49-51, holotype 9(♀). 48, ad. 9(♂) from Sri Lanka, Kandy. 47, T_4; 48, genital papillae, anterior view; 49, leg 1; 50, leg 9; 51, pygidium, sternal view. Scale a: Figs 47-50; b: Fig. 51.

with thin pointed stalks. Short pubescence hairs at bases of setae arranged in two whorls, one of them very close to the base. Pubescence longest on lateral parts of tergites. The laterosternal furrows strongly bent inwards.

Bothriotricha. All bothriotricha but T_3 with simple very thin axes and short pubescence of straight almost erect hairs which are branched most distally. T_3 with thicker axes and distal fusiform swelling, the latter 0.3 of the length of bothriotrix; distal part of T_3 almost glabrous, middle part with dense and short pubescence of oblique hairs. Relative lengths of bothriotricha: $T_1 = 100$, $T_2 = 166$, $T_3 = 85$, $T_4 = 126$, $T_5 = ?$.

Genital papillae (described from the adult male from Kandy, Sri Lanka). 3 times longer than wide, with straight inner side, lateral side evenly rounded, glabrous, seta 0.2 of the length of papilla; base segment well developed, length almost 0.4 of the length of papilla.

Legs. All legs 5-segmented. Setae on coxa and trochanter of leg 9 furcate, their main branch annulate and pointed, secondary branch on coxal seta rudimentary, pointed, glabrous and on trochanter annulate and pointed; length of main branch $\approx$ 25 μm. More anteriorly these setae with rudimentary, pointed, glabrous secondary branch. On most anterior legs the seta on trochanter is much thinner than coxal seta.

Tarsi of legs 1 - 9 slender, tapering, somewhat bow-shaped, distal half almost cylindrical. Tarsi of leg 1 almost glabrous, 4.3 times as long as greatest diameter, those of leg 9 3.8 times as long as greatest diameter; tarsi of leg 9 with minute pubescence. Tarsus of leg 1 with only one distal tergal seta, about 0.1 of the length of tarsus; tarsus of leg 9 with two tergal setae, both tapering, pointed, glabrous, proximal one = 19, distal one = 7 μm, proximal seta almost 0.3 of the length of tarsus and 2.4 times as long as distal seta. A triangular pointed appendage on anterior side of femur of leg 1, length = 5 μm.

All legs with almost straight thin main claw and small setose anterior secondary claw. On leg 1 main claw = 16, secondary claw = 6 μm; on leg 9 main claw = 17, secondary claw = 11 μm; main claw not fully 0.3 of the length of tarsus in all legs.

Pygidium. Tergum. Posterior margin almost straight, serrate with 6 teeth/lobe. Setae subequal, tuft-like, but with shorter hairs than on the tergites. a_1 curved outwards, somewhat converging, a_2 and a_3 somewhat curved inwards; st cylindrical, blunt, somewhat S-shaped, almost glabrous. Index of tergal setae: $a_1 = a_3 = 7$, $a_2 = 6.5$; $a_1 - a_1 = 15$, $a_1 - a_2 = 30$, $a_3 - a_3 = 41$, $st = 12$, $st - st = 13$ μm; $st - st/a_1 - a_1 = 0.9$, $a_1/a_1 - a_1 = 0.5$, $a_1/a_1 - a_2 = 1.2$, $a_1 - a_1/a_2 - a_3 = 2.9$. Tergum glabrous.

Sternum. Posterior margin between b_1 straight; setae blunt, b_1 and b_2 subcylindrical, somewhat tapering, the former densely pubescent and the latter almost glabrous; b_3 cylindrical and with distinct pubescence. Index of sternal setae: $b_1 = 42$, $b_2 = 13$, $b_3 = 12$, $b_1 - b_1 = 37$, $b_2 - b_2 = 50$, $b_3 - b_3 = 25$, $b_1 - b_2 = 9$, $b_1/b_1 - b_1 = 1.1$, $b_1/b_2 = 3.2$, $b_2/b_1 - b_2 = 1.4$, $b_3/b_3 - b_3 = 0.5$.

Anal plate circular, with two short subcylindrical branches protruding backward from posterior margin. Branches with oblique posterolateral truncation on sternal side, each carrying one distal ovoid bladder-shaped appendage with distinct thin cylindrical stalk; these appendages twice longer than wide, 0.3 of the length of plate and carrying a distinct, dense pubescence of erect hairs. Circular part of plate almost glabrous, cylindrical appendages with dense, short pubescence.

Remarks. Two *Sphaeropauropus* specimens have been reported previously from Réunion (Remy, 1957a). They were assigned to the only species known at that time, *S. malayus* Silvestri (Silvestri, 1930). A comparison of Remy's description of his material with the results of my later redescription of the species (Scheller, 1998) indicates that two species are involved. There are distinct differences in the shape of the antennal globuli g, the claws and genital papillae and in the proportion $b_1/b_1 - b_1$ and $b_2/b_1 - b_2$.

Because the similarities between *S. reunionensis* and the other species of the genus are even weaker, the relationships of the species are not yet possible to trace.

GENERAL REMARKS ON DISTRIBUTION

Our knowledge of the taxonomy and distribution of the pauropod species is still very poor and therefore it is not surprising that about half of 38 species reported above are either new to science or have been collected outside their previously known range, sometimes far outside. So e.g., three species are here reported new to Switzerland and Greece, two countries, which are rather well investigated thanks to earlier collecting of zoologists from both Geneva (Scheller, 1976, 1977a, b, 1981a) and France (Scheller, 1973). Including the species reported here, we know now 29 species from Switzerland and 34 from Greece.

An earlier review of the occurrence of the genus *Samarangopus* (Scheller, 1996) shows a range from Madagascar in the west to New Caledonia in the east and from New South Wales in Australia in the south to Thailand in the north. However, the range seems to be much wider. It now includes Nepal (Scheller, 2000) and the present study shows that the genus occurs in continental Africa too.

Another genus, *Sphaeropauropus*, might have a similar range. It was long thought to be restricted to the Australasian islands of Java, the Philippines and Réunion, but it has now been discovered far outside. There are further reports from China (Zang & Chen, 1988), Thailand (Scheller, 1995) and Nepal (Scheller, 2000) and here the genus is reported from Sri Lanka too.

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New molecular and morphological data on the *"Euscorpius carpathicus"* species complex (Scorpiones: Euscorpiidae) from Italy, Malta, and Greece justify the elevation of *E. c. sicanus* (C. L. Koch, 1837) to the species level

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New molecular and morphological data on the *"Euscorpius carpathicus"* species complex (Scorpiones: Euscorpiidae) from Italy, Malta, and Greece justify the elevation of *E. c. sicanus* (C. L. Koch, 1837) to the species level. - The first mitochondrial DNA phylogeny (based on 17 unique haplotypes) is presented for a number of scorpion populations from Italy, Malta, and Greece, previously classified under the "catch-all" name *Euscorpius carpathicus* (Linnaeus, 1767). A comparative analysis of the mitochondrial gene for 16S (large subunit) ribosomal RNA suggests that at least two clearly separated lineages are present. However, neither of these belongs to *E. carpathicus* (L.) in a strict sense, which was limited to Romania in a recent morphological study. The first, "western" lineage, found in northern and central Italy (also present in southern France, Slovenia, Croatia, and Austria) corresponds to *E. tergestinus* (C. L. Koch, 1837) as recently defined by Fet & Soleglad. Another monophyletic, "southern" lineage is elevated here to the species rank as *E. sicanus* (C. L. Koch, 1837). Originally described from Sicily, *E. sicanus* includes as new synonyms *E. carpathicus canestrinii* (Fanzago, 1872) and six subspecies described by Caporiacco: *E. c. calabriae*, *E. c. ilvanus*, *E. c. garganicus*, *E. c. argentarii*, *E. c. palmarolae*, and *E. c. linosae*. Morphology confirms the

existence of two lineages: *E. sicanus* is characterized by a unique tricho-bothrial pattern and number where series *eb*, and in some populations also series *eb$_a$*, have 5 trichobothria (all *E. tergestinus* possess only four of them). *E. sicanus* is found in southern Italy (including Sicily and Sardinia), northern Africa, Malta, and Greece. The enigmatic "*E. mesotrichus* Hadži" from Greece also belongs to *E. sicanus*.

Key-words: Scorpions - trichobothria - 16S mtDNA - biogeography - phylogeny - Southern Mediterranean - Italy - Malta - Greece.

INTRODUCTION

Scorpions of the genus *Euscorpius* Thorell, 1876 (Scorpiones: Euscorpiidae) are very common in southern Europe. they are ecologically diverse and they occupy a variety of habitats from xeric to mesic, from the Mediterranean shoreline to the high altitudes of the Alps and of the Balkan.

Linnaeus (1767: 1038) described *Scorpio carpathicus* from the Transylvanian Alps (Romania) (now *Euscorpius carpathicus*, the type species of the genus). Thorell (1876) introduced the new generic name *Euscorpius*. Numerous species have been described in *Euscorpius*; the traditional taxonomy of this genus, based mainly on morphosculpture and coloration characters, is complicated and confusing (Fet & Sissom, 2000).

C. L. Koch (1850: 86-87) reviewed all the *Euscorpius* species in his series "Die Arachniden", and clearly divided these species into three groups according to the number of trichobothria ("Grübchen") on the ventral aspect of the pedipalp patella (called tibia by many earlier authors). The large and conspicuous trichobothria (sensory bristles) of *Euscorpius* were then also used as taxonomic characters by Hadži (1929, 1930, 1931) and by Caporiacco (1950) who utilised total trichobothrial counts on different aspects of the pedipalp chela and patella. In the 50 years since Caporiacco's revision (which was mostly confined to the Italian forms, and only touched upon material from other countries), many authors paid attention to the intricate and intriguing taxonomy of this most common European scorpion genus (Bonacina, 1980; Ćurčić, 1972; Fet, 1986, 1993, 1997a, 1997b; Fet & Braunwalder, 2000; Kinzelbach, 1975; Lacroix, 1991a, 1991b; Scherabon, 1987; Vachon, 1963, 1975, 1978, 1981; Vachon & Jaques, 1977; Valle, 1975).

For almost a century, only four species were listed in *Euscorpius*: *E. carpathicus*, *E. germanus*, *E. flavicaudis* and *E. italicus* (see e.g., Birula, 1900, 1917; Caporiacco, 1950; Kraepelin, 1899; Vachon, 1963, 1981; Vachon & Jaques, 1977). Bonacina (1980) reestablished *E. mingrelicus* (Kessler, 1874). Further revisional work resulted in 12 formally recognized species: *E. alpha* Caporiacco, 1950, *E. balearicus* Caporiacco, 1950, *E. beroni* Fet, 2000, *E. carpathicus* (Linnaeus, 1767), *E. gamma* Caporiacco, 1950, *E. germanus* (C. L. Koch, 1837), *E. hadzii* Caporiacco, 1950, *E. flavicaudis* (DeGeer, 1778), *E. italicus* (Herbst, 1800), *E. koschewnikowi* Birula, 1900,   *E. mingrelicus* (Kessler, 1874), and *E. tergestinus* (C.L. Koch, 1837) (Fet, 2000; Fet & Sissom, 2000; Gantenbein *et al.*, 2000a, 2001; Scherabon *et al.*, 2000; Fet & Soleglad, 2002).

One of the most recent developments in *Euscorpius* taxonomy was the introduction of molecular techniques which started with the pioneering paper of Gantenbein *et al.* (1999) on application of allozyme and 16S ribosomal RNA gene sequence analyses to assess the phylogeny of this genus. This study provided the first ever published DNA-based phylogeny for scorpions. These data revealed a phylogenetic relationship between four species (*E. flavicaudis*, *E. carpathicus*, *E. italicus*, and *E. germanus*) which differed from the former, morphology-based views on evolution of this genus (Hadži, 1931; Kinzelbach, 1975). Further work included more detailed genetic and morphological analysis of *E. germanus*, *E. alpha*, and *E. gamma* (Gantenbein *et al.*, 2000a; Scherabon *et al.*, 2000) as well as *E. carpathicus* (Gantenbein *et al.*, 2001; Huber *et al.*, 2001).

Gantenbein *et al.* (2001) elevated *E. c. balearicus*, an isolated *E. carpathicus* population from the Balearic Islands from subspecific to species status. Most recently, Fet & Soleglad (2002) conducted a morphological analysis of the "*E. carpathicus*" complex by including a number of new characters (foremost of which are individually mapped patellar trichobothria). They restricted the species *E. carpathicus* to populations from Romania, elevated one Balkan subspecies to species status (*E. hadzii*), confirmed species status for *E. koschewnikowi* from Greece, and assigned a number of Italian subspecies to the species *E. tergestinus*. However, the five species established by Gantenbein *et al.* (2001) and Fet & Soleglad (2002) did not yet embrace all diversity of populations traditionally placed under *E. carpathicus*.

The goal of this paper is to continue the study of the polymorphic and poorly studied "*E. carpathicus*" complex in Italy, with additional comparative material now available from Malta and Greece.

MATERIAL AND METHODS

MATERIAL

For this study, we used DNA sequences from 18 specimens belonging to the "*E. carpathicus*" complex, represented by 14 unique haplotypes. Two additional sequences, belonging to *E. tergestinus*, have been taken from the GenBank database (Gantenbein *et al.* 1999, 2001; Huber *et al.*, 2001): *Ec*LM1, AJ389377; *Ec*PR2= *Ec*PR1, AJ309211. GenBank also provided the outgroup sequence of *E. italicus*, *Ei*TO1 = AJ298067. All 14 new sequences have been deposited in GenBank under accession numbers AY090076 to AY090089 (see below).

Specimens used for DNA analysis: *E. sicanus* (=*E. c. ilvanus* Caporiacco, 1950; = *E. c. argentarii* Caporiacco, 1950; =*E. c. canestrinii* (Fanzago, 1872); =*E. c. garganicus* Caporiacco, 1950): *Ec*NE1 (AY090078), *Ec*NE2 (AY090076), Italy, Nebrodi Mts., beech forest (1500 m), northeastern Sicily, Italy, 30 September 1999 (V. Vignoli); *Ec*TR1 (AY090084), San Domino Island, Tremiti Islands (Adriatic Sea), Foggia, Apulia, Italy, 30 August 2001 (V. Vignoli); *Ec*GA1 (AY090085), Vico del Gargano, Foggia, Apulia, Italy, 29 August 2001 (V. Vignoli); *Ec*PU1 (AY090077), Punta Ala, Tuscany, Italy, 10 August 2000 (M. Stiegler & P. Weiner) (identical to haplotypes from Follonica and Siena, Tuscany, Italy); *Ec*AR1 (AY090079), Le Piane, Mt. Argentario, Grosseto, Tuscany, Italy, 22 January 2000 (V. Vignoli) (identical to another haplotype

from Siena and a haplotype from Orbetello); *Ec*GG1 (AY090081), Campese, Giglio Island, Tuscany, Italy, 30 May 2000 (V. Vignoli) *Ec*GI1 (AY090082), Cala Maestra, Giannutri Island, Tuscany, Italy, 30 May 2000 (V. Vignoli) (identical to another haplotype from Giglio Island); *Ec*SD1 (AY090083), Lu Fraili, northeastern Sardinia, Italy, 16 August 2001 (V. Vignoli); *Ec*MT1 (AY090086), *Ec*MT2 (AY090087), Buskett, Malta, 17 September 2001 (P. J. Schembri); *Ec*OL2 (AY090088), Mt. Olympus, Thessaly, Greece, 15 May 2001 (V. Fet); *Ec*KB1 (AY090089), Kalambaka, Thessaly, Greece, 14 May 2001 (V. Fet). *E. tergestinus*: *Ec*LM1 (AJ389377), La Morra, Piedmont, Italy, 20 September 1996 (I. & B. Gantenbein); *Ec*PR2 (AJ309211), Procchio, Elba, Italy, 4 October 1996 (I. & B. Gantenbein); *Ec*SZ1 (AY090080), Le Grazie, Porto Venere, La Spezia, Liguria, Italy, June 2001 (D. Facheris). Outgroup *E. italicus*: *Ei*TO1 (AJ298067), Tortoreto, Abruzzo, Italy (M. Bellini).

For our morphological analysis we used additional extensive material deposited in zoological museums (see below, under "Material studied").

METHODS

DNA techniques: We used a standard protocol as described in Gantenbein *et al.* (1999, 2000a). For DNA analyses, genomic DNA was extracted from fresh or preserved (in ethanol 94-98%) muscle tissue (usually pedipalp or metasoma) by using a standard phenol/chloroform precipitation method (Sambrook *et al.*, 1989) or the Qiagen™ DNeasy extraction kit. Extracted DNA was amplified by the polymerase chain reaction (PCR) in the Perkin Elmer 2400 PCR Thermocycler by using conditions and primers as described in Gantenbein *et al.* (1999). The mitochondrial LSU (large ribosomal subunit) 16S rRNA PCR primers corresponded to the positions 12,867-12,884 and 13,328-13,308 in the *Drosophila yakuba* mitochondrial genome, or to the positions 11,173-11,190 and 11,625-11,606 in the *Limulus polyphemus* mitochondrial genome (Lavrov *et al.*, 2000). The forward primer is a scorpion-specific version of the "universal" primer 16Sbr, or LR-J-12887, while the reverse primer has a scorpion-specific sequence designed by one of the authors (V.F.). The resulting PCR product was verified on 1% agarose electrophoretic gel and purified by Ultrafree MC 30000 cellulose filters (Millipore Inc.) or using "Rapid Gel Extraction Systems" columns (Concert™). Automated Sanger dideoxy sequencing of the double-stranded PCR product was performed at the Molecular Genetics Instrumentation Facility, University of Georgia (Athens, GA), on the ABI 9600 Sequencer (US team) or at the MWG-Biotech automated DNA sequencing service, Esersberg, Germany (Italian team).

Phylogenetic analyses: 17 mtDNA sequences representing different haplotypes were aligned using Clustal X 1.81 (Thompson *et al.*, 1997). DNA sequences used in earlier studies were downloaded from the GenBank nucleotide sequence database. Identical haplotypes were not considered in further analyses.

The software package PAUP* Version 4.0b10 (Swofford, 1998) was used for sequence analysis to perform phenetic (Felsenstein, 1984) and cladistic phylogenetic analyses. We are aware that these methods are based on different assumptions, but all of these are expected to estimate the "true" phylogeny in the absence of long-branch-attraction (Page & Holmes, 1998): genetic distance calculation, Maximum Parsimony (MP), and Neighbour-Joining (NJ) analysis (Saitou & Nei, 1987). However, it appears

that especially for the choice of "correct" tree topology MP is superior to Maximum Likelihood (ML) in the "inverse Felsenstein zone" (Swofford *et al.*, 2001). For choosing the most appropriate DNA substitution model for pairwise distances, we initially estimated a NJ tree using JC69 distance (Jukes & Cantor, 1969). This tree was then used for estimating the ML parameters from 56 different substitution models. Maximum likelihood ratio tests were then performed in a nested design by using the program MODELTEST 3.06 (Posada & Crandall, 1998), which is implemented in PAUP*. Details about likelihood ratio tests are given in Huelsenbeck & Crandall (1997) and Huelsenbeck & Rannala (1997). The rate heterogeneity among sites was assumed to follow a gamma distribution (shape parameter α was ML-estimated) with four categories, each represented by its mean (Yang, 1996). In a further step, the molecular clock hypothesis (i.e., equal rates across all sequences) was tested by using the c^2 approximated likelihood ratio test statistics. The hierarchical LRT statistics suggested the HKY85 + Γ model (Hasegawa *et al.*, 1985) for the 16S gene, as it was found also by Gantenbein *et al.* (2001). The test for the molecular clock hypothesis was rejected at the 5% level ($2d = 2(l_0-l_1) = 840.27 - 823.90 = 32.74$, $P_{\chi}^2 = 0.005$). Therefore, the NJ clustering algorithm was chosen, which allows for unequal branch lengths (Page & Holmes, 1998). For weighted MP analysis the tree space was explored by 100 heuristic tree searches and by randomizing the order of the sequence input in PAUP*. The transition/transversion (Ti/Tv) ratio was ML-estimated to 2.73; therefore we weighted Tv three times over Ti. The four gaps in the data set were treated as the fifth base (McGuire *et al.*, 2001). Confidence limits of individual nodes were assessed by using non-parametric bootstrapping (Felsenstein, 1985; Swofford *et al.*, 1996).

ABBREVIATIONS

MZUF, Museo Zoologico "La Specola" dell'Università di Firenze, Florence, Italy; NMW, Naturhistorisches Museum Wien, Vienna, Austria; ZMH, Zoologisches Museum Universität Hamburg, Hamburg, Germany; NMM, Naturhistorisches Museum, Mainz, Germany; HNHM, Hungarian Natural History Museum, Budapest, Hungary; NMNHS, National Museum of Natural History, Sofia, Bulgaria; VF, private collection of Victor Fet. Specimen numbers from MZUF are given as AAA/BBBB, where AAA is the "collection number" and BBBB is the "catalog number".

RESULTS

The resulting 16S rDNA phylogeny in our study reveals two well-separated monophyletic lineages among the material traditionally placed under *E. carpathicus* (Fig. 8). One of these lineages, recovered by all analyses, is readily identified as *E. tergestinus* (C. L. Koch, 1837) as defined by Fet & Soleglad (2002). All of its specimens possess a "standard" trichobothrial formula (eb_a=4, eb=4). In the molecular phylogeny of Gantenbein *et al.* (2001, Tab. 1, Figs 2, 3), *E. tergestinus* was represented (as *E. carpathicus*) by populations from Mathis (Alpes-Maritimes, France), La Morra (Piedmont, Italy), Procchio (Elba, Tuscany, Italy), Vernazza (Liguria, Italy), Hochosterwitz (Austria), and Mala Duba (Croatia), spanning the entire geographic range of this species as currently accepted by Fet & Soleglad (2002). The same species
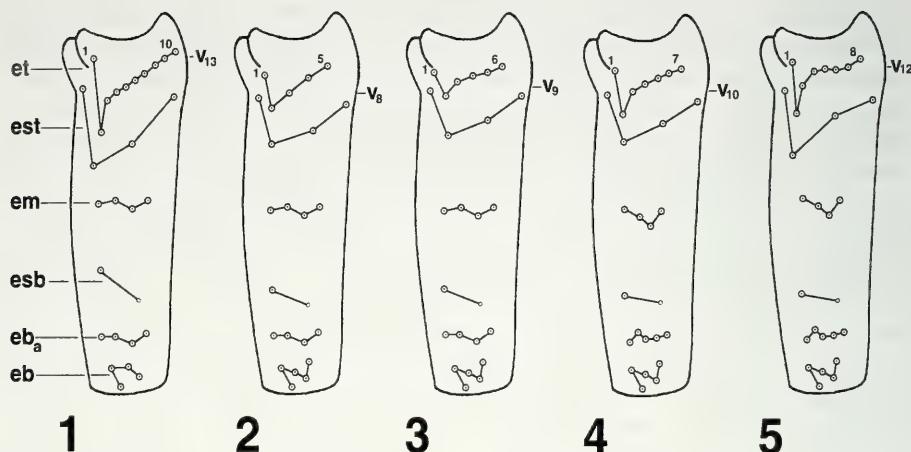
FIGS 1-5

Idealized trichobothrial patterns of the external aspect of the pedipalp patella in two *Euscorpius* species exhibiting *eb* series = 4 (with *E. sicanus* populations exhibiting) *eb* = 5. **1.** *Euscorpius balearicus*, Balearic Islands, Spain; **2.** *E. sicanus*, Sicily, Italy; **3.** *E. sicanus*, Mt. Argentario, Italy; **4.** *E. sicanus*, Mt. Olympus, Greece; **5.** *E. sicanus*, Sardinia, Italy. Series *et* = external terminal, *est* = external subterminal, *em* = external median, *esb* = external suprabasal, eb_a = external basal-a, and *eb* = external basal; *v* = ventral.

was characterized (as *E. carpathicus*) by Huber *et al.* (2001) who studied more populations from Austria and Slovenia. In our data, a new haplotype of *E. tergestinus* from La Spezia (Liguria) groups together with previously known haplotypes from Piedmont and Elba.

Another 16S rDNA clade, also recovered in our study by all analyses (Fig. 8), includes a diverse array of populations, located mainly in Italy (Tuscany, Sicily, Sardinia, Gargano, and Tremiti Islands) but also in Malta and Greece (Thessaly). This clade is treated below as a separate species. The senior synonym available for it is *Scorpius sicanus* C. L. Koch, 1837 according to Article 23 of the International Code of Zoological Nomenclature (ICZN, 1999).

Separation of this second monophyletic clade (phylogenetic species), distinct in the DNA phylogeny, is also supported by our morphological analysis (Figs 1-5). The most important feature separating *E. sicanus* from *E. tergestinus* (and from another related species, e.g., *E. balearicus*), is its unique trichobothrial pattern and number where the external patellar series *eb* (and in some populations, also series eb_a) has 5 trichobothria. All specimens examined of *E. tergestinus* and *E. balearicus* possess only 4 trichobothria in these series; Fig. 1. A number of Italian subspecies (*E. c. canestrinii, E. c. calabriae, E. c. ilvanus, E. c. garganicus, E. c. argentarii, E. c. palmarolae,* and *E. c. linosae*) (Caporiacco, 1950) also belong to this new lineage, and are therefore formally synonymized here with *E. sicanus*. The closest relative of *E. sicanus* is *E. hadzii*, which also has 5 trichobothria in series *eb* but is distinguished by 6 to 7 trichobothria in series eb_a (Fet & Soleglad, 2002).

E.c.calabriae
E.c.sicanus
E.c.ilvanus
E.c.palmarolae
E.c.argentarii
E.c.garganicus
E.c.linosae
E.c.'mesotrichus'
E.hadzii
E.c.canestrinii

Patella: *ventral*

E.c.linosae
E.c.palmarolae
E.c.sicanus
E.c.ilvanus
E.c.argentarii
E.c.calabriae
E.c.garganicus
E.c.canestrinii
E.c.'mesotrichus'
E. hadzii

Patella: *eb_a*

E.c.calabriae
E.c.palmarolae
E.c.sicanus
E.c.ilvanus
E.c.argentarii
E.c.garganicus
E.c.linosae
E.c.'mesotrichus'
E. hadzii
E.c.canestrinii

Patella: *et*

FIG. 6

Trichobothria statistics of *Euscorpius carpathicus* subspecies now placed in the synonymy of *E. sicanus*. *E. hadzii* Caporiacco, 1950 is used as a reference taxon. Series *et* = external terminal, eb_a = external basal-a, *eb* = external basal; *cv* = coefficient of variation.

Figs 2-5 show schematized trichobothrial patterns illustrating the five tricho-bothria of the patellar *eb* external series diagnostic of *Euscorpius sicanus*. In contrast *E. balearicus* exhibits the typical four trichobothria in the same series (Fig. 1). Also of
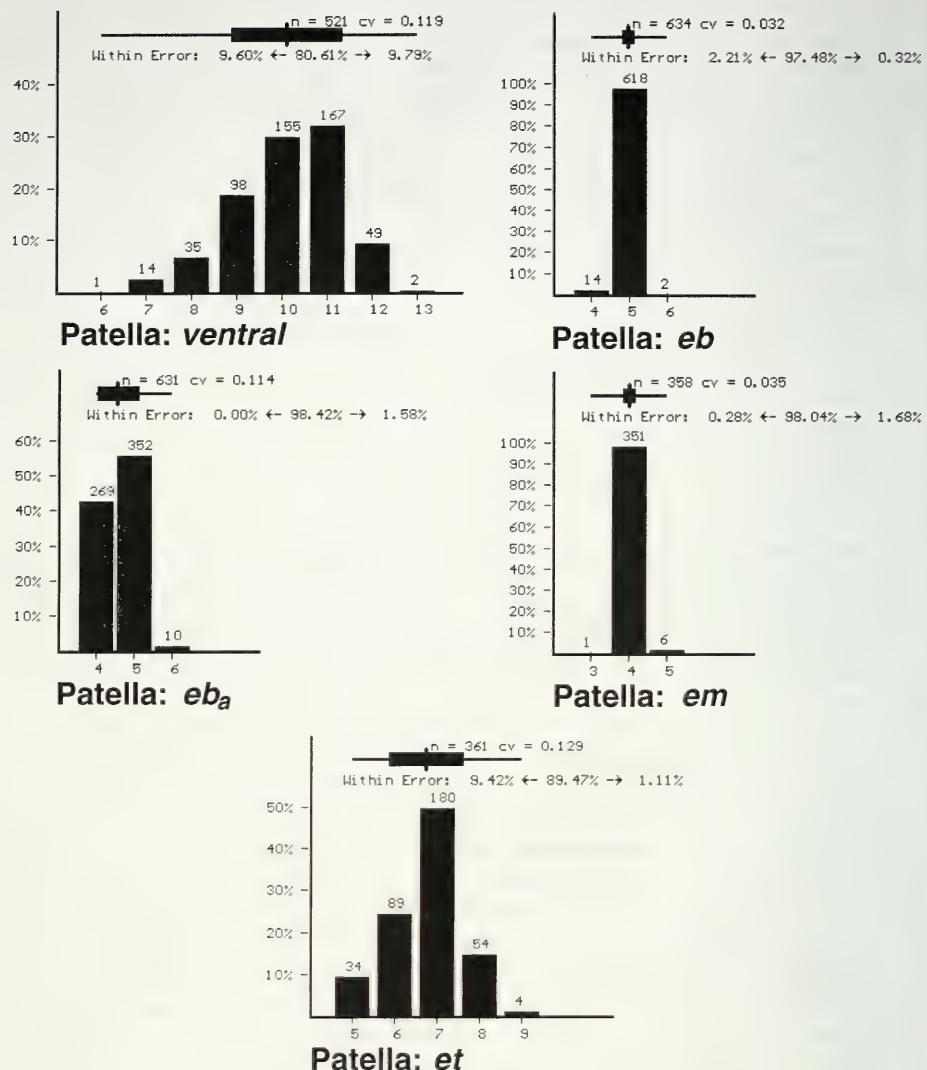
FIG. 7

Complete statistics of patellar trichobothria count in all *Euscorpius sicanus* specimens examined. Series *et* = external terminal, *em* = external median, *eb$_a$* = external basal-a, *eb* = external basal; *cv* = coefficient of variation.

interest is that *E. sicanus* populations from Greece and Sardinia (Figs 4-5) exhibit a tendency for five trichobothria in the *eb$_a$* series, in contrast to some other populations around Italy, including Sicily and Malta, which usually have *eb$_a$*=4.

Also apparent from Figs 1-5 is the larger number of trichobothria in the *et* and ventral patellar series for Greek and Sardinian populations. Further statistical data for several subspecies defined by Caporiacco (1950) and herein synonymized with *E. sicanus* are shown in the histograms in Figs. 6-7.
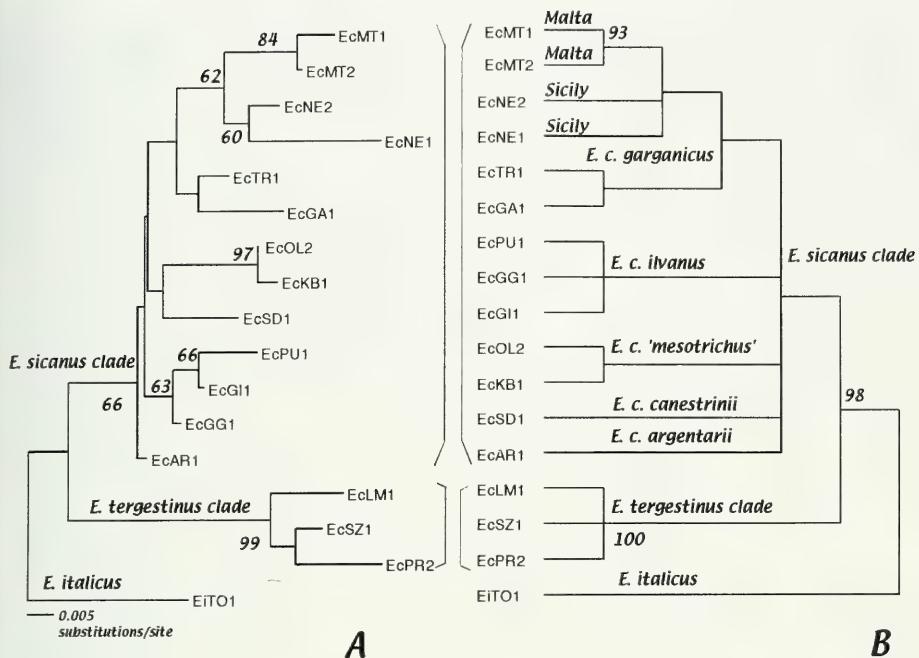
FIG. 8

DNA phylogeny of *E. tergestinus* and *E. sicanus* (branch labels refer to previously recognized subspecies). **A,** Neighbour-joining (NJ) tree using Maximum Likelihood (ML) distances as an input matrix. HKY85 + Γ-ML distances (Hasegawa *et al.*, 1985) were calculated with the following parameters (base frequencies: $p_A = 0.36$, $p_T = 0.41$, $p_C = 0.10$, Ti/Tv ratio = 2.73 (κ = 7.87), gamma shape parameter $\alpha = 0.098$, respectively. **B,** Strict consensus tree of Maximum Parsimony (MP) analysis (55 equally parsimonious trees of 79 steps). CIu and RI were 0.72, respectively. Numbers at nodes are bootstrap values. Outgroup, *E. italicus*.

Euscorpius sicanus (C. L. Koch) can be diagnosed as a small to medium sized species with a somewhat thin metasoma; trichobothrial counts: patella ventral = 6-13 (9-11); external, $eb = 5$, $eb_a = 4$-5, $esb = 2$, $em = 4$, $est = 4$, $et = 5$-9 (7); pectinal tooth counts, 8-10 (9) in males; 6+-8??+ (7+) in females.

Number of trichobothria in series eb (=5) and $eb_a = (4$-5) are key diagnostic characters for this species. *E. sicanus* is contrasted here with its closest relative *E. hadzii*, which also has $eb = 5$ as follows: $eb_a = 4$-5, as opposed to 6-8 (7) in *E. hadzii*; $em = 4$, as opposed to 4-5 in *E. hadzii*. Position of eb_3 in *E. sicanus* is in straight line with eb_2 - eb_3 - eb_4, eb_3 usually situated below eb_2; in *E. hadzii*, eb_2 - eb_3 - eb_4 is not in straight line, eb_3 usually situated above eb_2. Number of trichobothria in series eb (=5) and em (= 4) distinguishes *E. sicanus* from *E. carpathicus*, and eb (=5) distinguishes *E. sicanus* from *E. balearicus*, *E. tergestinus*, and *E. koschewnikowi*.
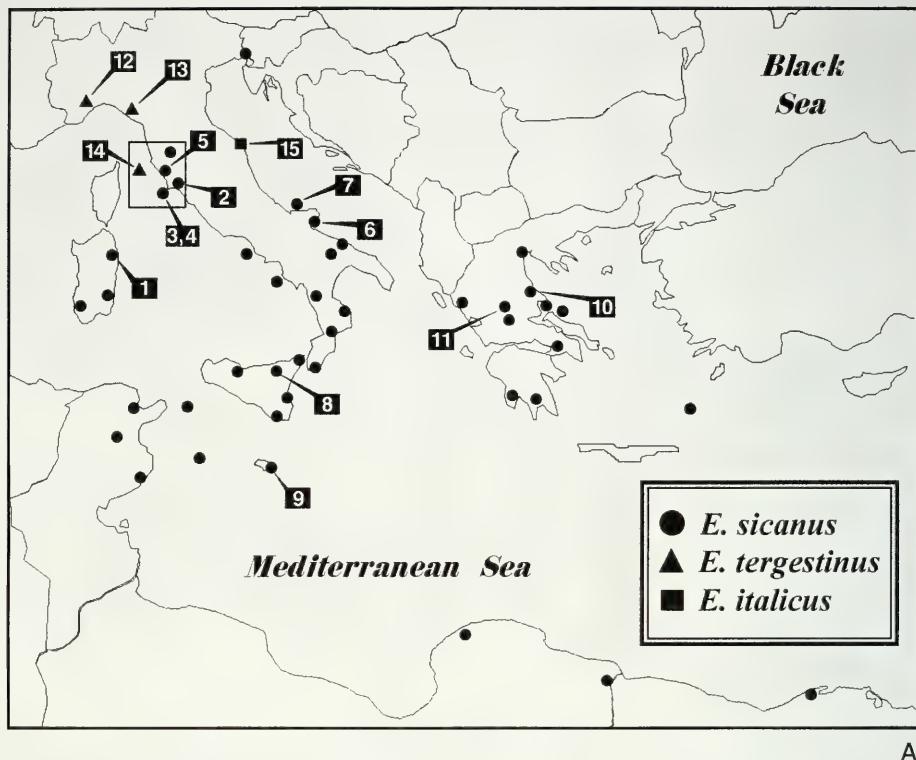
A
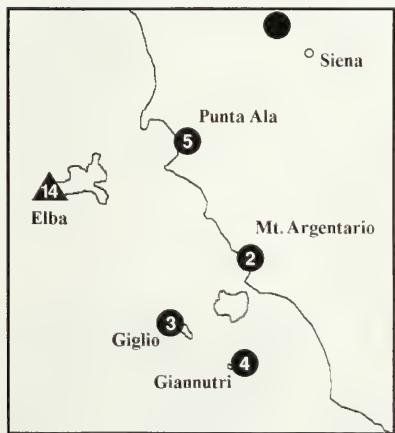
B

Fig. 9

A, Distribution map of *E. sicanus*, indicating DNA sampling sites. **B,** Map detail of the boxed area. *E. sicanus*: **1,** Sardinia; **2,** Mt. Argentario; **3,** Giglio; **4,** Giannutri; **5,** Punta Ala; **6,** Gargano; **7,** San Domino, Tremiti; **8,** Nebrodi, Sicily; **9,** Malta; **10,** Mt. Olympus, Greece; **11,** Kalambaka, Greece. Outgroup samples: *E. tergestinus*: **12,** La Morra, Piedmont; **13,** La Spezia, Liguria; **14,** Procchio, Elba; *E. italicus*: **15,** Tortoreto.

DISCUSSION

The phylogenies from the 16S data presented here support our morphological data. One should keep in mind that the partial sequence of this gene represents only a small fraction of the mitochondrial genome. It is also known that different genes may underlie different genealogies and that gene trees may not reflect species phylogenies

(Pamilo & Nei, 1988). Incomplete lineage sorting processes and introgression of mtDNA between two species/subspecies might be responsible for such inconsistencies (Page & Charleston, 1998; Avise, 2000). Recently, evidence for asymmetric introgression of mtDNA in a buthid subspecies in the nuclear background of another subspecies and its subsequent complete fixation have been reported (Gantenbein & Largiadèr, 2002). However, in euscorpiids, so far, the phylogenetic information of the mitochondrial 16S fragment has always been in concordance with independent nuclear genetic markers (allozyme data) (Gantenbein *et al.*, 1999, 2000a, 2001; Scherabon *et al.*, 2000). Therefore, the phylogenetic pattern of the 16S gene is very likely to represent the "species tree" for the genus *Euscorpius*. For the taxonomic consequences we strongly rely here on the phylogenetic species concept (PSC) (Cracraft, 1989) as we elevate *E. carpathicus sicanus* to the species level. Therefore, it seems reasonable to use morphological differentiation, *i.e.* trichobothrial patterns of the external aspect of patella, as a further support for the identified phylogenetic lineages. However, we are also aware that "deep" genetic divergences within morphologically conservative phylogenetic groups such as scorpions or other arachnids in general have been reported in the absence of obvious morphological differences (Gantenbein *et al.*, 2000a, 2000b; Bond *et al.*, 2001).

Scorpius sicanus C. L. Koch, 1837 was described from Sicily, and later synonymized with *Euscorpius carpathicus* (L.). Caporiacco (1950) has also mentioned this form, as a subspecies *E. carpathicus sicanus*, for the south of peninsular Italy (Apulia, western Calabria), Malta, and the northern African coast. *Scorpius canestrinii* Fanzago, 1872 was described from Sardinia, and later was synonymized with *E. carpathicus*. Caporiacco (1950) treated these two forms as valid subspecies; our data show that they belong to the same species.

Caporiacco (1950) also established a number of new subspecies for *E. carpathicus*, mainly from Italy. Our morphological investigation of type material for all of these subspecies, and DNA sequences corresponding to some of them, demonstrate that six of Caporiacco's subspecies (*E. c. linosae, E. c. garganicus, E. c. ilvanus, E. c. argentarii, E. c. palmarolae,* and *E. c. calabriae*) belong to *E. sicanus* (see below). Several other subspecies accepted or described by Caporiacco (1950) (*E. c. apuanus, E. c. concinnus, E. c. niciensis, E. c. aquilejensis, E. c. picenus, E. c. oglasae,* and *E. c. corsicanus*) were recently synonymized with *E. tergestinus* by Fet & Soleglad (2002).

Kinzelbach (1975) studied Greek populations of *E. carpathicus*, but did not discuss external patellar trichobothria at all; as we know now, this character set is crucial for the understanding of the genus *Euscorpius* (Vachon, 1974, 1975; Soleglad & Sissom, 2001; Fet & Soleglad, 2002). Vachon (1975) applied the patellar trichobothria analysis to all known *Euscorpius* species. At the same time, the important work of Valle (1975) on *E. carpathicus* appeared independently; Vachon (1975) in a footnote (p. 645) informed that his paper was already in print when he received Valle's publication.

Valle (1975) attempted to analyse some of Caporiacco's subspecies described from Italy by using external patellar trichobothria. Probably because Valle used the old system of designations established by Vachon (1963), his data were ignored by subse-

quent researchers (e.g. Fet, 1986, 1997a, 2000; Scherabon, 1987; Lacroix, 1991a, 1991b), who adhered to the new system by Vachon (1974, 1975, 1978, 1981). Note that Valle scored external patellar trichobothria summarily for both pedipalps, while Vachon's numbers refer to a single pedipalp. The two systems differ in assignments of individual trichobothria into several groups ("series"). However, comparing *Euscorpius* trichobothrial schemes in Fig. 1 in Valle (1975), Fig. 3 in Vachon (1963; "old system"), and Fig. 17 in Vachon (1975; "new system"), we can adjust Valle's system to Vachon's conventions used today (Table 1). This rather elaborate adjustment allows one to use Valle's valuable statistical data, which are based on the analysis of large series from various localities, and which can be interpreted in much more detail than the data of Caporiacco (1950) who used only total counts for patellar external trichobothria. Valle (1975) was the first to identify the most important trend in *E. carpathicus* trichobothriotaxy: variation of the B2 series (i.e. *eb*). Valle averaged the summary numbers for both pedipalps together (Valle, 1975: Tables 1-4, Figs. 4, 6, 8-10), and his numbers can be established in terms of Vachon (1975) as given in the Table 2. Recently, Fet & Soleglad (2002) restricted the name *E. carpathicus* to populations from Romania and established the species *E. tergestinus* (C. L. Koch, 1837) for populations from northern Italy. Valle (1975) specifically noted that all specimens from Piedmont and Liguria have B2=6 (*eb*=4); this refers to *E. tergestinus*. In our DNA phylogeny (Fig. 8), one of the monophyletic lineages is referable to *E. tergestinus*; the other Italian lineage (*Euscorpius sicanus*) is unexpectedly diverse geographically, and includes a number of populations, which are discussed below.

Sicily (type locality of *E. c. sicanus*). For specimens from Sicily, Vachon (1975, Fig. 31) illustrated the character *eb*=5, and suggested that this could be a good character, sufficient to elevate this taxon to the species rank. Valle (1975) reported that in specimens from around the island B2 varies from 6 to 8 (*eb* from 4-4 to 5-5). From his Fig. 6 it is evident that *eb*=5 specimens are concentrated in the north (corresponding to our DNA samples from Nebrodi Mts.). It remains to be seen if only *E. sicanus* is present in Sicily, or if in fact there are two sympatric species of *Euscorpius* as is the case on mainland Italy. Since Koch's type of *E. sicanus* originated from Messina (the very northeastern point of Sicily), this name can be associated with Sicilian specimens having *eb*=5.

Apennine Peninsula. E. sicanus is found in central and southern parts of the Apennine peninsula, from Tuscany to Calabria. Our data show that this species is found in Tuscany inland (Siena) as well as on the Tyrrhenian coast (Mt. Argentario, Follonica, Punta Ala), and on the nearby islands of the Tuscany Archipelago: Giannutri, Giglio, Capraia, Gorgona (MZUF; Caporiacco, 1950; our data). Further south we find this species on Palmarola (MZUF) and on the Capri (ZMH) Islands in the Tyrrhenian sea.

Caporiacco (1950) listed *E. c. sicanus* not only for Sicily (type locality) but also for the mainland Italy, from Apulia (Bari area) and western Calabria. In addition, Caporiacco (1950) described several new subspecies, the differences between which, according to our study of his type material, are insignificant and usually amount to

minor variations in morphosculpture or coloration. *E. carpathicus calabriae* was described from Calabria; *E. c. argentarii*, from an isolated massif (ecological refugium) of Mt. Argentario in Tuscany; and *E. c. garganicus* from Apulia (Gargano Peninsula and Tremiti Islands in the Adriatic Sea). Marcuzzi *et al.* (1963: 81-88) conducted a statistical study on a number of populations from Apulia (using total trichobothrial counts), and could not find characters separating *E. c. garganicus* from other Apulian populations. Valle (1975, Fig. 8, Table 3) demonstrated B2=8 (*eb*=5) for most of southern Italy; he specifically noted (p. 228) that this character is not found north of Tuscany and Marches. However, we discovered a population with *eb*=5 also in Trieste (ZMH); two independent museum records (F. Werner in 1891 and C. Attems in 1901) exclude the possibility of erroneous labeling. It remains to be seen if *E. sicanus* occurs naturally in the northern Adriatic region or if the Trieste record represents an introduced population.

Two other island populations near Italy have been given subspecific names: *E. c. palmarolae* from the Palmarola Island in the southern Tyrrhenian sea (off the Latium coast) and *E. c. ilvanus* from the Tuscany Archipelago. Both also exhibit *eb*=5. Our DNA data shows that all Tuscany populations (mainland and island alike) exhibit very close haplotypes (genetic distance less than 1%), and belong to the same monophyletic clade as *E. sicanus* (Fig. 8, A).

The syntype series of *E. c. ilvanus* originates from several islands of the Tuscany Archipelago (including Elba), and also from Capri. However, our analysis of this material shows that all of Caporiacco's specimens from Elba and Capri have *eb*=4, i.e., they belong to *E. tergestinus*. This is confirmed by our DNA data (see above). Valle (1975, Fig. 4) also noted Elba populations as having B2=6 (*eb*=4); Capri may have two sympatric species (which is also possible for Sicily; see above).

According to Caporiacco, the rest of the syntype series of *E. c. ilvanus* originates from Giannutri, Cerboli, Capraia, Giglio, and Gorgona islands. Only syntypes from Giannutri, Cerboli and Capraia are in MZUF, all with *eb*=5 and *eb$_a$*=4; among these, we selected a lectotype from Giannutri. Valle (1975) provides statistics for 145 specimens from Giglio and 74 from Giannutri, most of which have B2=8 (*eb*=5); he also shows this character for specimens from Cerboli, Gorgona, Mt. Argentario, the coast of Tuscany, and Capri (Valle, 1975, Fig. 4).

DNA haplotypes from Giannutri (EcGI1) and Giglio (EcGG1) islands are very close to each other and to a haplotype from the mainland (EcPU1) (Punta Ala, identical with Follonica and Siena haplotypes) (Fig. 8). Another haplotype from Tuscany, which also falls in the *E. sicanus* clade, is found on Mt. Argentario (EcAR1); it is identical to a second haplotype from Siena and to one from Orbetello.

The morphological character combination *eb*=5 and *eb$_a$*=4, which is typical for Sicily, persists through some Italian populations of *E. sicanus*, such as those in Tuscany, including the islands of Tuscany Archipelago (type series of *E. c. ilvanus*), Mt. Argentario (type series of *E. c. argentarii*); Gargano Peninsula and Tremiti Islands (type series of *E. c. garganicus*; additional material studied); and Calabria (type series of *E. c. calabriae*).

Sardinia. Our DNA phylogeny (Fig. 8) demonstrates that the Sardinian population (*Ec*SD1), described originally as a separate species (*Scorpius canestrinii*), falls within the monophyletic clade of *E. sicanus.* Caporiacco (1950) studied 75 specimens from this population and treated it as a separate subspecies, *E. c. canestrinii..* For the Sardinian population, Vachon (1975) mentioned *eb*=5. Valle (1975, Table 4) reported B2=8 (*eb*=5-5), but he also noted that B3 is normally 10 (*eb$_a$*=5-5). This was confirmed in a detailed analysis and redescription by Vachon (1978) who studied 142 specimens from Sardinia. These specimens consistently possessed *eb*=5 (94.7% of 284 pedipalps scored), as illustrated in Vachon (1978, Fig. 6; 1981, Fig. 11). Some variation in *eb$_a$* was observed; while it was predominantly 5 (in Vachon's series, 71.8% of pedipalps), others (e.g. in a population from Sordogno that we studied) have *eb$_a$* =4 (25.7%) and even 6 (2.5%). Vachon (1978: 329) noticed that the feature *eb*=5 was shared with the Sicilian subspecies (*E. c. sicanus*).

Pelagie Islands and Pantelleria. These small islands (belonging to Italy) in the southern Mediterranean Sea between Sicily and Africa are known to have populations of "*E. carpathicus*". Caporiacco (1950) described a new subspecies from Linosa Island, *E. c. linosae,* but our analysis of the type specimen from MZUF clearly indicates that it belongs to the *E. sicanus* clade (*eb*=5, *eb$_a$*=4). Valle (1975, Table 2) analysed 13 specimens from Linosa, all with B2=8 (*eb*=5); he also mentioned a population from Lampedusa Island but did not characterize it. Crucitti (1993: Fig. II) reported "*E. carpathicus*" from Pantelleria Island. No DNA data are as yet available from scorpions from the Pelagie Islands or Pantelleria.

Malta. Caporiacco (1950) was the first to report *E. c. sicanus* for Malta. Vachon (1975: 643) mentioned that specimens from Malta have *eb*=5. At the same time, Kinzelbach (1975), who expanded an alleged "hybrid between *E. carpathicus* and *E. mesotrichus*" to many Mediterranean populations, listed it also for Malta. Schembri & Schembri (1990) reported specimens from all of the Maltese islands (Malta, Gozo, Comino, and St. Paul's Islands) as belonging to *E. c. candiota* Birula, 1903, following Kinzelbach (1975). This identification was also given by Kritscher (1992) and Schembri (1992). Our analysis of Kritscher's original specimens deposited at NMW and of new Maltese material clearly indicates that it belongs to the *E. sicanus* clade (*eb*=5, *eb$_a$*=4), as stated by Caporiacco (1950). Trichobothria counts also show similarity between populations on Malta and Sicily, with series *et* and *v* about 20% lower on Sicily and Malta as compared to Sardinia. Our DNA phylogeny further demonstrates that the Maltese population is closest to the Sicilian *E. sicanus* (Fig. 8, A). This is to be expected, given the geological history and biogeographic affinities of the Maltese fauna; the Maltese Islands were connected to Sicily, and possibly to North Africa, in Late Miocene (Messinian) times, and may have been connected again during Pleistocene sea-level lows (Thake, 1985; Schembri, 1992; Hunt & Schembri, 1999). As for *E. c. candiota* Birula, this taxon was originally described from Crete (Birula, 1903), and Kinzelbach's (1975, 1982) interpretation that this species ranges beyond the Aegean Sea is not justified by either morphology or DNA analysis (Fet *et al.*, in preparation).

North Africa. "*E. carpathicus*" has been reported many times from isolated localities along the north African Mediterranean coast (Tunisia, Libya, Egypt) (Simon, 1885; Birula, 1909; Caporiacco, 1950; Valle, 1975; Vachon, 1952, 1975, 1978; Fet & Sissom, 2000; Stathi & Mylonas, 2001). Specimens from North Africa were listed under *E. c. sicanus* by Caporiacco (1950) and by Vachon (1975, 1978). Our analysis of museum material shows that these populations conform to the "*sicanus*" trichobothrial formula. Valle (1975, Table. 4) analysed 15 specimens from Tunisia and one from Libya (Cyrenaica), but his data are unclear since he quoted B2 as mostly 9 or even 10. In this case, Valle might have added up the eb_a and eb series, thus $eb=eb_a=5$. Vachon (1978: 328) mentioned specimens from Tunisia (Carthage and Tunis) with $eb=eb_a=5$, and from Tunisia (Sfax) and Libya (Cyrenaica) with $eb=5$ and $eb_a=4$. We analysed four specimens from Tunisia (Tunis and Djebel bou Kournine), all with $eb=5$ and $eb_a=4$. However, a single specimen from Tripoli, Libya (Birula, 1909) that we have seen in NMW has $eb=eb_a=4$. Recently, Stathi & Mylonas (2001) reported a new locality at Senebat Lauela Gorge in Kuff National Park, Ruins of Cyrrini, 5 km SE of El Beida, Libya.

No DNA is available from the northern African enclaves yet; it remains to be seen if these are true relict populations or if they have been introduced via human activity in historical times. Such transplantation are not unusual in *Euscorpius*; see for example, the populations of *E. flavicaudis* in England (Fet & Sissom, 2000), and Austrian populations of *E. tergestinus* (Huber *et al.*, 2001; as *E. carpathicus*).

Madeira. The single specimen known from the island of Madeira (Portuguese territory in the Atlantic Ocean) was first listed by Kinzelbach (1982) under "*E. mesotrichus*". An analysis of this specimen (deposited in the NMM) demonstrated that it has $eb=eb_a=5$, i.e. it is closest to the populations from Tunisia and Sardinia. The Madeira population of *Euscorpius* is the westernmost known. As with the North African populations, it remains to be shown if the one from Madeira was introduced or represents a true relict. Madeira is known for its relict Mediterranean-type biota.

Greece. A nomenclatural controversy surrounds some poorly studied Greek populations belonging to the "*E. carpathicus*" complex (Fet, 2000; Fet & Braunwalder, 2000; Fet & Sissom, 2000). Kinzelbach (1975) observed sympatry of two morphologically different forms in Greece (Thessaly) and separated *E. carpathicus* (L.) from another species, which he reported as "*E. mesotrichus* Hadži, 1929". This name, however, is permanently invalid since it refers to *E. carpathicus mesotrichus* Hadži, a junior primary homonym of *E. italicus mesotrichus* Hadži (Caporiacco, 1950; Fet 1997b) (ICZN Article 57.2). The name "*E. mesotrichus* Hadži" was used later by some authors (Michalis & Kattoulas, 1981; Kinzelbach, 1982, 1985; Kritscher, 1993), while others (Vachon, 1978, 1981; Fet, 1986, 1997a) did not comment on Kinzelbach's division.

Fet & Sissom (2000) agreed with the observation by Kinzelbach (1975) that at least two different species of the "*E. carpathicus*" complex are present in Thessaly, and tentatively accepted the name *E. tergestinus* for one of them as an available senior synonym of the homonymous *E. c. mesotrichus* Hadži (these names were first synonymized by Caporiacco, 1950). Our present study indicates that the Thessalian

populations, indeed, belong to two species. However, neither of them is *E. tergestinus*; as defined recently by Fet & Soleglad (2002), this species is not found in Thessaly. One of Thessalian species, referred to as *E. carpathicus* s.str. by Kinzelbach (1975), is not yet identified; it does not belong to *E. carpathicus*(L.), which was recently restricted to Romania (Fet & Soleglad, 2002). Another Thessalian form, listed as *E. mesotrichus* by Kinzelbach (1975) and as *E. tergestinus* by Fet & Sissom (2000), according to the morphological features, belongs to *E. sicanus*. The DNA analysis also places the Thessalian populations of "*E. mesotrichus*" (*Ec*OL2, *Ec*KB1) into the *E. sicanus* clade. While in MP analysis the branching order is unresolved (Fig. 8, B), in the ML analysis (Fig. 8, A) these Thessalian populations form a sister group to *E. sicanus* populations from Sardinia, the Adriatic region, Sicilia, and Malta as an outgroup clade.

The distribution of *E. sicanus* in Greece is not limited to the populations from Mt. Olympus massif and northern Pindus Mts. (Kalambaka, valley of the Peneus River), the DNA of which we analysed. According to the museum data studied by V.F. and M.E.S. (which include the ample material previously discussed by Kinzelbach (1975) and Kritscher (1993)), this species is common in Greece found from Macedonia and Thessaly (with the Sporades) to Attica and Peloponnese (see map at Fig. 9, A). The specimens reported by Michalis & Kattoulas (1981) as "*E. mesotrichus*" from Lakonia, Peloponnese, also probably belong to the same species. Two "Group B" specimens of *E. carpathicus* reported by Fet (2000, p. 55) from Peloponnese (Mistras) also belong to *E. sicanus*. Judging from trichobothrial data of specimens (pp. 43-45, Fig. 3) recently reported from many localities from the Peloponnesus (Mistras) under *E. carpathicus* by Crucitti & Bubbico (2001) these populations also belong to *E. sicanus*. The Greek populations are the subject of a continuing study (Fet *et al.*, in preparation). Their morphology varies, but all have the unmistakable "*sicanus*" signature of *eb*=5; many populations (Mt. Olympus, Mt. Ossa, Sporades, Taygetos Mts.) also have eb_a=5. *E. sicanus* reaches its highest recorded altitude at Mt. Tsumerka, Pindus Mts., 1500 m a.s.l. (Kritscher, 1993, under "*E. mesotrichus*").

We thus confirm the presence of more than one form of the "*Euscorpius carpathicus*" complex in Thessaly, as first stated by Kinzelbach (1975). While one of these (erroneously cited as "*E. mesotrichus* Hadži") belongs to *E. sicanus*, the nomenclature of the other form, which has *eb*=4, remains to be established. It cannot be called *E. carpathicus*, since that species was shown to be restricted to Romania by Fet & Soleglad (2002). A number of former subspecies described in the genus *Euscorpius* have been recenlty elevated to the species rank using molecular and morphological criteria (*E. tergestinus, E. hadzii, E. koschewnikowi, E. balearicus, E. alpha, E. gamma*; see Gantenbein *et al.*, 2000, 2001; Scherabon *et al.*, 2000; Fet & Soleglad, 2002); other former subspecies have been synonymized with these species, therefore largely eliminating the need of subspecies category in *Euscorpius*.

It is important to notice that *E. sicanus* was not found on the majority of the Aegean islands (for trichobothrial data on specimens from 9 islands including Crete, see Fet, 1986, 2000). It was, however, recorded from the Sporades (Skiathos, Alonyssos, Skopelos) under *E. mesotrichus* by Kritscher (1993). Furthermore, a form with *eb*=5 was found on Tria Nisia, a small island group in the southwestern Aegean Sea (Fig. 9, A); this specimen was recorded by Werner (1936: 17) as *E. carpathicus*).

As a result of our study, one more valid species, *E. sicanus*, with a complex (and likely ancient) geographic distribution and with considerable intraspecific variation, is added to the genus *Euscorpius*. Further investigations on the *"Euscorpius carpathicus"* species complex are desirable, especially for a number of poorly studied (both named and unnamed) populations in the Balkans, Turkey, and Italy.

TAXONOMIC CONCLUSIONS

Euscorpius sicanus (C. L. Koch, 1837)

Scorpius sicanus C. L. Koch, 1837: 106, Pl. CVII-CVIII, Figs 247-248. TYPE MATERIAL. **Holotype** (female) from Messina, Sicily, Italy (leg. Wagner), formerly in J. Sturm's collection in Nuremberg (Birula, 1917), now presumed lost (Fet & Sissom, 2000). The designation of a neotype according to the ICZN (Article 75) is desirable for the purposes of taxonomic stability.

SYNONYMS

Scorpius canestrinii Fanzago, 1872: 78, Fig. 1, 1a, 1b, **syn. n. Lectotype** (designated by Kovařík, 1997: 182): female (HNHM 2277-214), Sardinia, Italy (coll. Canestrini, det. Fanzago). **Paralectotype**: 1 male (pictured by Vachon, 1978: Figs 1-7) (HNHM), Sardinia, Italy.

Euscorpius carpathicus linosae Caporiacco, 1950: 184, 227, **syn. n. Lectotype** (the only available specimen; designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74), female (MZUF 30/5970), Linosa Island, Pelagie Islands (Mediterranean Sea), Agrigento, Italy. **Paralectotypes** (depository unknown): 8 specimens, the same data as for the lectotype.

Euscorpius carpathicus garganicus Caporiacco, 1950: 189, 226, **syn. n. Lectotype** (designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74): male (MZUF 90/5902), San Domino Island, Tremiti Islands, Foggia, Apulia, Italy, 16 April 1940 (Pomini). **Paralectotypes** (all from Foggia, Apulia, Italy, coll. Pomini): 4 females, 3 males (MZUF 88/5903-5909), Caprara Island, Tremiti Islands, Foggia, Apulia, Italy, 13 April 1940; 3 females, 1 male (MZUF 86/5892-5895), Bosco Ginestra, Gargano, Apulia, 20 April 1940; 2 females (MZUF 86/5896-5897), Alveo del Lago S. Egidio, 20 April 1940; 1 male (MZUF 87/5910), Foresta Umbra, Gargano, Apulia, September 1940; 1 female (MZUF 92/5910), Sfilze, Gargano, Apulia, 25 April 1940; 3 females (MZUF 91/5899-5901), Sannicandro Garganico, Gargano, Apulia, 25 April 1940. Other paralectotypes (depository unknown): 44 specimens from Gargano and Tremiti.

Euscorpius carpathicus ilvanus Caporiacco, 1950: 195, 229 (in part), **syn. n. Lectotype** (designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74): male (MZUF 98/5745), Giannutri Island, Tuscany, Italy, 1878 (G.B. Toscanelli). **Paralectotypes** (all from Livorno, Tuscany, Italy): 5 females, 1 male (MZUF 98/5744, 99/5746-5751), same label as lectotype; 4 females, 7 males (MZUF 118/5725-5735), Cerboli Island, 1879 (G.B. Toscanelli); 1 female (MZUF 117/5755), Capraia Island, November 1927. Other paralectotypes (depository unknown): 14 males, Gorgona Island; 39 males, Giglio Island. *Note*: part of the original syntype series, i.e., specimens, from Elba Island (6 females, 2 males, MZUF 120/5736-5743, January 1879 (G.B. Toscanelli)) and from Capri Island (1 female, 2 males, MZUF 141/5752-5754, 31 July 1879 (Corio)) are excluded from this designation since they belong to *E. tergestinus*.

Euscorpius carpathicus argentarii Caporiacco, 1950: 196, 228, **syn. n. Lectotype** (designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74): female (MZUF 5977): Mt. Argentario, Grosseto, Tuscany, Italy, 3 November 1874 (Mayor). **Paralectotypes:** 6 females, 1 juv. male (MZUF 5978-5979, 6256-6260), from the same locality as the lectotype.

Euscorpius carpathicus palmarolae Caporiacco, 1950: 196, 228, **syn. n. Lectotype** (designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74), Palmarola Island, Pontine Islands (Tyrrhenian Sea), Latium, Italy, 1878 (G.B.Toscanelli). **Paralectotypes**: 2 females, 1 male (MZUF 111/5755, 5758-5759), from the same locality as the lectotype.

Euscorpius carpathicus calabriae Caporiacco, 1950: 200-201, 228 (in part), **syn. n. Lectotype** (designated here from the syntype series in order to preserve stability of nomenclature according to the ICZN Article 74), 1 female (MZUF 61/5887), Colle di Pizzo, Arena, Catanzaro, Calabria, Italy, 1874 (G. Cavanna); **Paralectotypes** (all from Calabria, Italy, coll. G. Cavanna): 6 females, 2 males (MZUF 61/5883-5886, 5888-5891), same locality as lectotype; 2 females (MZUF 57/5871, 5873), Filandari, Catanzaro, 13 April 1874; 1 female (MZUF 59/5874), Foresta della Mongiana near Mt. Pecoraro, Catanzaro, 25 June 1874; 1 female (MZUF 172/5868), Palmi, Reggio Calabria, 6 June 1874; 1 female, damaged (MZUF 170/5875), Timenovo (mountains near Oppido), Reggio Calabria, 22 May 1874. Other paralectotypes (depository unknown, all from Calabria, Italy): 3 males, Fago del Soldato; 1 female, Monte Consolino (Stilo); 19 males, Monte Oliveto; 17 males, Soveria Manetti; 1 female, Vibo Valenzia; female, Melossena Cave near Maratea (Potenza, Basilicata). *Note*: 5 specimens from the syntype series (MZUF 171/5876, 5879; 172/5869, 5870, 5880; Palmi, Reggio Calabria, 1874 (G. Cavanna)) do not match *E. calabriae* in morphology (*eb*=4) and are not included in the paralectotype list (they may belong to *E. tergestinus*).

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Scorpius sicanus: C. L. Koch, 1850: 86; Fanzago, 1872: 83, Fig. 4.

Euscorpius carpathicus: Birula, 1909: 518; Werner, 1936: 17; Caporiacco, 1950: 178-209 (in part); Marcuzzi *et al.*, 1963: 81-88; Curcić, 1972: 84-86 (in part); Valle, 1975: 209-234 (in part); Crucitti, 1993: 289-291, Fig. 2 (in part); Fet & Braunwalder, 2000: 19, Fig. 3 (in part); Fet & Sissom, 2000: 357 (in part); Stathi & Mylonas, 2001: 289 (in part).

Euscorpius sicanus: Pavesi, 1876: 430; Birula, 1900: 15; Birula, 1917: 105; not Kulczyński, 1887: 349-354 (Tyrol), misidentification.

Euscorpius canestrinii: Birula, 1900: 15; Birula, 1917: 105.

Euscorpius carpathicus sicanus: Caporiacco, 1950: 183, 227; Valle, 1975: 219, 223; Vachon, 1975: 642-643, Fig. 31; Vachon & Jaques, 1977: 413; Vachon, 1978: 328; Lacroix, 1991a: 19, Fig. 64; Fet & Sissom, 2000: 365.

Euscorpius carpathicus canestrinii: Caporiacco, 1950: 184, 227; Valle, 1975: 233; Vachon & Jaques, 1977: 415, 431; Vachon, 1978: 321-230, Fig. 1-7; Vachon, 1981: 199, Fig. 7, 11; Lacroix, 1991a: 19, Fig. 58; Kovařík, 1997: 178, 182, Fig. 1-4; Fet & Sissom, 2000: 363.

Euscorpius mesotrichus: Kinzelbach, 1975: 30-38 (in part); Kinzelbach, 1982: 61-63 (in part); Kinzelbach, 1985, Map IV (in part); Michalis & Kattoulas, 1981: 109-110; Kritscher, 1993: 385-386 (in part).

Euscorpius carpathicus calabriae: Valle, 1975: 232; Bartolozzi *et al.*, 1987: 296; Lacroix, 1991a: 19 (*calabria*!); Fet & Sissom, 2000: 362.

Euscorpius carpathicus ilvanus: Valle, 1975: 219; Bartolozzi *et al.*, 1987: 296; Lacroix, 1991a: 19; Fet & Sissom, 2000: 364.

Euscorpius carpathicus garganicus: Bartolozzi *et al.*, 1987: 296-297; Lacroix, 1991a: 19.

Euscorpius carpathicus argentarii: Bartolozzi *et al.*, 1987: 296; Lacroix, 1991a: 19; Fet & Sissom, 2000: 361.

Euscorpius carpathicus palmarolae: Bartolozzi *et al.*, 1987: 296; Lacroix, 1991a: 19; Fet & Sissom, 2000: 362.

Euscorpius carpathicus linosae: Bartolozzi *et al.*, 1987: 296; Lacroix, 1991a: 19; Fet & Sissom, 2000: 364.

Euscorpius carpathicus candiota (not *Euscorpius candiota* Birula, 1903, misidentification): Kinzelbach, 1975: 34, 36-37 (in part); Schembri & Schembri, 1990: 20; Kritscher, 1992: 185-188, Figs. 1-4.

Euscorpius carpathicus carpathicus: Kritscher, 1993: 383-384 (in part), misidentification.

Euscorpius tergestinus (not *Scorpius tergestinus* C. L. Koch, 1837, misidentification): Fet & Sissom, 2000: 372 (in part; Greece).

MATERIAL STUDIED

Specimens used for DNA analysis (see above); type material of *E. c. linosae*, *E. c. garganicus*, *E. c. ilvanus*, *E. c. argentarii*, *E. c. palmarolae*, *E. c. calabriae* (see above) (MZUF); other museum materials: **GREECE.** 2 females (ZMH), Plataria, Epirus, 20 June 1986 (K. Michalis & P. Dolkeras); 1 juv. female (NMM 0176), road between Rodohori (=Rodochorion) and Naoussa, Macedonia, August 1972 (H. Georgiadis); 1 male (NMW 2130), Chortiatis near Thessaloniki, Macedonia, 9 October 1966 (J. Gruber); 1 male (NMW 16006), Mt. Tsumerka, 1500 m, Pindus Mts., 18 August 1990 (H. Sattmann); 14 females, 7 males (VF), Visitsa, 800 m, Mt. Pilion, Thessaly, 7 May 2001 (V. Fet); 32 females, 11 males (VF), Spilia, 800 m, Mt. Ossa (=Kissavos), Thessaly, 9 May 2001 (V. Fet); 4 females (VF), Kalambaka, 200 m, Thessaly, 14 May 2001 (V. Fet); 3 females, 1 male (NMW 16.035/1-4), Litohoro (=Lithochorion), near Mt. Olympus, Thessaly, 9 June 1984 (E. Kritscher); 1 female (VF), 3 km N of Litohoro, Mt. Olympus, 15 May 2001 (V. Fet); 1 female, 1 juv. male (NMM 0209a), Agios Dionysios, 820 m, Mt. Olympus, Thessaly, 28 August and 10 September 1973 (H. Pieper); 1 female, 1 juv. male (NMM 0206), between Petra and Kokkinopilos, 520 m, Mt. Olympus, Thessaly, 29 September 1973 (H. Pieper); 3 females (NMM 0261), Mt. Olympus, Thessaly, 26 May 1974 (H. Malicky); 6 females, 4 males (ZMH), Karditsa, 560 m, Thessaly, 24 June 1986 (K. Michalis & P. Dolkeras); 4 females (ZMH 30), Sykouri (=Sykourion), Thessaly (K. Michalis & P. Dolkeras); 1 male, 1 female (NMW 16040/1-2), Lazareta, Skiathos Island, Sporades, Thessaly, 24 June 1985 (E. Kritscher); 1 female (NMW 16041), Skopelos Island, Sporades, Thessaly 14 June 1985 (E. Kritscher); 2 females (NMW 16031/1-2), Milia, Alonissos Island, Sporades, Thessaly, 11 June 1985 (E. Kritscher); 1 juv. (NMW), Mt. Parnes, Attica, 1200 m, 18 May 1969 (H. Rausch); 2 females (NMNHS 68), Mistras, Laconia, Peloponnese, 18 September 1983 (P. Beron & V. Beshkov); 1 male (NMW 16039/2), road between Leptokaria and Karia, 14 km, Mani, Peloponnese, 9 June 1984 (E. Kritscher); 4 females, 4 males (NMM 0201) Taygetos Mts., W of Profitis Ilias, 1200 m, spruce forest, Peloponnese, 28 September 1973 (R. Kinzelbach); 1 male (NMW 2193), Tria Nisia (the southernmost island), Dodecanese Islands, Aegean Sea (O. Wettstein). **ITALY.** 5 specimens (NMW 11299), Messina, Sicily, 1906 (K. Holdhaas); 4 females, 3 males (ZISP 98-913), Sordogno, Sardinia (A. Krausse); 8 females, 3 males (ZMH), Mt. St. Angelo, Gargano, Apulia, 6-8 September 1925; 1 female, 1 male juv. (ZMH), Capri Island, August 1928; 2 females, 1 male (ZMH), Trieste, September 1891 (F. Werner); 3 females, 2 males (ZMH), Trieste, 23 December 1901 (C. Attems). **MADEIRA.** 1 female (NMM 0204), 2 April 1971 (U. Hecker) (Kinzelbach, 1982; as identified as "*E. mesotrichus*"). **MALTA.** 2 specimens (NMW 1857), Wied-il-Babu, near Zurrico [=Wied Babu near Zurrieq], Malta, 16 April 1913; 1 female (NMW), Zurrico [=Zurrieq], Malta, 16 April 1913; 5 females, 1 male (NMW 15.040), Floriana, Malta, 15 June 1990 (E. Kritscher); 1 female (NMW 15.038), Marsalform [=Marsalforn], Gozo Island, 28 May 1990 (E. Kritscher); 6 females, 1 male (NMW 15.039), Marsalform [=Marsalforn], Gozo Island, 31 May 1990 (E. Kritscher). **TUNISIA.** 2 females (ZMH), Tunis, 23 May 1910 (Wegehn); 1 female, 1 male (NMW 2180), Djebel bou Kournine, 13 April 1913 (F. Werner). **LIBYA.** 1 male (NMW 2179), Tripoli, August 1906 (B. Klaptocz).

DISTRIBUTION

Italy (with Sardinia and Sicily), Malta, Greece, northern Africa (Tunisia, Libya, Egypt), Madeira.

TABLE 1. Correspondence of external patellar trichobothrial designations in *Euscorpius* by Valle (1975) and Vachon (1975).

Valle (1975) (scored for both sides)	Vachon (1975 and later) (scored for each side)
D1 (variable)	(et-right - 1) + (et-left - 1)
D2 (constant, always 8, i.e. 4 on each side)	2 from et and 2 from est on each side =4
D3 (constant, always 6, i.e. 3 on each side)	[(est-right - 2) + 1] + [(est-left - 2) +1] =6 (est is always 4)
D4 (variable)	em-right + em-left
B4 (constant, always 4, i.e. 2 on each side)	(esb-right + esb-left)=4 (esb is always 2)
B3 (variable)	eb_a-right + eb_a-left
B2+B1 (B2 is variable; B1 is always 2, as it includes only 1 on each side)	eb-right + eb-left

TABLE 2. Variation of external patellar trichobothrial series B2 (Valle, 1975) corresponding to series *eb* (Vachon, 1975).

Valle (1975)	Vachon (1975 and later)
B2	*eb*
6 (3-3)	4-4
7 (3-4 or 4-3)	4-5 or 5-4 (for an asymmetric individual); or 4-4 & 5-5 (when averaged per locality)
8 (4-4)	5-5

ACKNOWLEDGEMENTS

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Le genre *Amphoteromorphus* (Cestoda: Proteocephalidea), parasite de poissons-chats d'Amérique tropicale: étude morphologique et approche biosystématique par électrophorèse des protéines

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The genus *Amphoteromorphus* (Cestoda: Proteocephalidea), parasite of neotropical catfishes : systematics including morphological data and protein electrophoresis. - The present paper provides a detailed morphological revision of the genus *Amphoteromorphus* together with a study of isoenzymes. The authors conclude that the concerned genus contains at present the following six species: *A. peniculus* Diesing, *A. parkamoo* Woodland, *A. piraeeba* Woodland, *A. piriformis* sp. n., *A. ovalis* sp. n. and *A. ninoi* sp. n. *A. peniculus* is unequivocally distinguished by irregularly alternating genital pores. *A. ninoi* is characterised by the number of testes, by the position of vitellaria and by the number of uterine diverticula; its specific isolation is confirmed by isoenzyme electrophoresis. The remaining four species are closely related. *A. piriformis* and *A. ovalis* possess distinctive embryophore shape. *A. ovalis* is also distinguishable by its electrophoretic profile.

Key-words: Cestoda - Monticelliidae - *Amphoteromorphus* - fish parasites - izoenzyme electrophoresis - new species - taxonomy.

INTRODUCTION

Le genre *Amphoteromorphus* Diesing, 1850, parasite de poissons chats en Amérique tropicale, comprend selon Freze (1969) et Schmidt (1986), trois espèces: *A. peniculus* Diesing, 1850 parasite de *Brachyplatystoma flavicans*, *A. piraeeba* Woodland, 1934 parasite de *B. filamentosum et de B. flavicans* et *A. parkamoo* Woodland, 1935 parasite de *Paulicea luetkeni*.

Des récoltes effectuées en 1992 et 1995 en Amazonie nous ont fourni un abondant matériel, dont quelques spécimens provenant d'un hôte inédit, *Brachyplatystoma vaillanti*. L'étude morpho-anatomique et génétique par électrophorèse des izoenzymes nous conduit à décrire trois espèces nouvelles dans ce genre.

MATÉRIEL ET MÉTHODES

Les hôtes (récoltés par des pêcheurs dans la région de Itacoatiara, dans le fleuve Amazone en 1992 et 1995) ont été disséqués et examinés immédiatement après leur mort. Le tractus digestif, fendu dans toute sa longueur, a été fixé dans une solution de formaldéhyde à 4 % bouillante. Après le tri au laboratoire, les helminthes ont été conservés dans l'éthanol à 75 %. Les cestodes ont été colorés au carmin chlorhydrique de Mayer, différenciés à l'éthanol acide, déshydratés, éclaircis dans l'eugénol et montés au Baume du Canada. Les coupes sériées transversales ou frontales de 12-15 µm d'épaisseur ont été colorées à l'Hématoxyline de Weigert / éosine et montées au Baume du Canada selon le processus récemment exposé par de Chambrier (2001). Les œufs ont été montés extemporanément dans l'eau distillée. Tous les parasites sont déposés au Muséum d'histoire naturelle de Genève (INVE) et dans la collection d'helminthologie de l'Institut Oswaldo Cruz (CHIOC).

Sauf indications contraires, les dimensions sont données en micromètres (µm).

Abréviations: ag: atrium génital; c: cirre; cd: canal osmorégulateur dorsal; cev: cirre évaginé; cg: cellules à cytoplasme granuleux; CHIOC = Institut Oswaldo Cruz, Rio de Janeiro; cm: musculature circulaire distale des ventouses; cv: canal osmorégulateur ventral; dc: canal déférent; du: diverticules utérins; eb: embryophore; ebe: embryophore externe; ebi: embryophore interne; ee: enveloppe externe; gm: glande de Mehlis; h: crochets; INVE = Département des invertébrés du Muséum d'histoire naturelle de Genève; lm: musculature longitudinale interne; MHNG = Muséum d'histoire naturelle, Genève; mo: membrane oncosphérique; MT = matériel-type; n = nombre de mesures ou d'observations; od: oviducte; on: oncosphère; oo: oocapte; ov: ovaire; pc: poche du cirre; PC = rapport longueur de la poche du cirre sur la largeur du proglottis; pep: paroi épaissie de la poche du cirre; PG = situation du pore génital en % de la longueur du proglottis; rm: musculature radiaire des ventouses; rs: réceptacle séminal; s: coque; sv: sphincter vaginal; te: testicules; tu: tronc utérin; ud: utéroducte; ut: utérus; vb: ventouses bilobées; vc: canal vaginal; vd: vitellogènes dorsaux; vdp: vitellogènes dorsaux paramusculaires; vi: vitelloducte; vv: vitellogènes ventraux; vvp: vitellogènes ventraux paramusculaire; x = moyenne; * = spécimens utilisés pour l'électrophorèse des protéines.

Les morceaux d'individus destinés à l'électrophorèse des protéines ont été placés dans un tube Eppendorf et conservés dans l'azote liquide, puis au congélateur (-80°C). Les échantillons ont ensuite été broyés individuellement au laboratoire dans 0.2 ml d'eau distillée. Cette source d'enzyme a été prélevée sur un rectangle de papier Whatman (1.0 x 0.2 mm) et stockées à -80°C. Les électrophorèses ont été réalisées sur gel d'amidon sous une tension d'environ de 80 V et d'une intensité maximale de 80 mA.

Les révélations enzymatiques ont été effectuées selon les techniques décrites par Pasteur *et al.* (1987) ou selon Hillis *et al.* (1996) pour l'enzyme GCDH.

Vingt-sept enzymes ont été testées: AAT (Aspartate amino-transférase, EC 2.6.1.1), ACO (Aconitase, EC 4.2.1.3), ACP (Phosphatase acides, EC 3.1.3.2), AK (Adénylate-kinase, EC 2.7.4.3), AKP (Alkaline-phosphatase, EC 3.1.3.1), ALD

(Aldolase, EC 4.1.2.13), CK (Créatine-kinase, EC 2.7.3.2), FK (Fructo-kinase, EC 2.7.1.4), GCDH (Glucose-déhydrogénase, EC 1.1.1.118), GLC (NAD-glucose-déhydrogénase, EC 1.1.1.47), GPI (Glucose-6-phosphate-isomérase, EC 5.3.1.9), GPD (Alpha-glycérophosphate-déhydrogénase, EC 1.1.1.8), G6PD (Glucose-6-phosphate-déhydrogénase, EC 1.1.1.49), 6PGD (Phosphogluconate-déhydrogénase, EC 1.1.1.43), HK (Hexokinase, EC 2.7.1.1), IDH (Isocitrate-déhydrogénase, EC 3.1.1.42), LAP (Leucine-aminopeptidase, EC 3.4.11.1), LDH (L-lactate-déhydrogénase, EC 1.1.1.27), MDH (Malate-déhydrogénase, EC 1.1.1.37), ME (Enzyme-malique, EC 1.1.1.40), MPI (Mannose-6-phosphate-isomérase, EC 5.3.1.8), NP (Purine-nucléoside-phosphorylase, EC 2.4.2.1), PEP (Peptidases, EC 3.4.-.-: Pep-A, Pep-B, Pep-C and Pep-D, correspondant au substrat suivant: Val-Leu, Leu-Gly-Gly, Lys-Leu, Phe-Pro) et PGM (Phosphoglucomutase, EC 2.7.5.1). La mobilité électrophorétique la plus lente est désignée par la lettre " a ".

RÉSULTATS

Amphoteromorphus Diesing, 1850

Monticelliidae La Rue, 1911, Zygobothriinae Woodland, 1933.

Scolex pourvu de quatre ventouses bilobées. Présence d'un métascolex plissé à la base du scolex. Musculature longitudinale interne plus développée au niveau des marges latérales des proglottis, fibres musculaires formées de petits faisceaux groupés en une couche bien délimitée. Pores génitaux unilatéraux ou irrégulièrement alternes (espèce-type). Poche du cirre allongée, muni d'un cirre non armé. Vitellogènes corticaux, parfois paramusculaires, en deux bandes dorsales et ventrales, aporales et postporales (pas de vitellogènes préporaux). Testicules médullaires, antérieurs à l'ovaire et disposés en un champ. Ovaire médullaire bilobé ou compact à contour irrégulier. Vagin toujours antérieur à la poche du cirre. Utérus formé d'un tronc utérin médullaire et de diverticules médullaires. Parasites de poissons siluriformes néotropicaux.

Espèce-type: *Amphoteromorphus peniculus* Diesing, 1850.

Amphoteromorphus peniculus Diesing   Figs 1-4

Amphoteromorphus peniculus Diesing, 1850: 560.

Hôte: Brachyplatystoma flavicans (Castelnau, 1855) (Pimelodidae); nom vernaculaire: Dourada.

Matériel examiné: Brésil, Villa dos Manes, type: 3 préparations totales, 5 préparations de coupes sériées, coll. Institut de Zoologie Neuchâtel, collecté par Natterer (numéroté: Wien 613), C 35/82-89, 21.01.1834. Brésil, Etat de Amazonas, Itacoatiara, INVE 19313, 19.09.92; INVE 22214, 13.09.92.

Localisation: Intestin.

DESCRIPTION

Strobiles acraspédotes, jusqu'à 50 mm de long. Tégument peu ou pas plissé. Proglottis matures et gravides larges de 945-1425 (x = 1265, n = 20) et longs de 475-655 (x = 570, n = 10).

Scolex long de 1090 (n = 1) et large de 2275 (n = 1). Métascolex peu plissé et légèrement plus large que le cou. Ventouses bilobées, longues de 675-715 (n = 3), pourvues d'une musculature radiaire développée. Rapport entre longueur des ven-
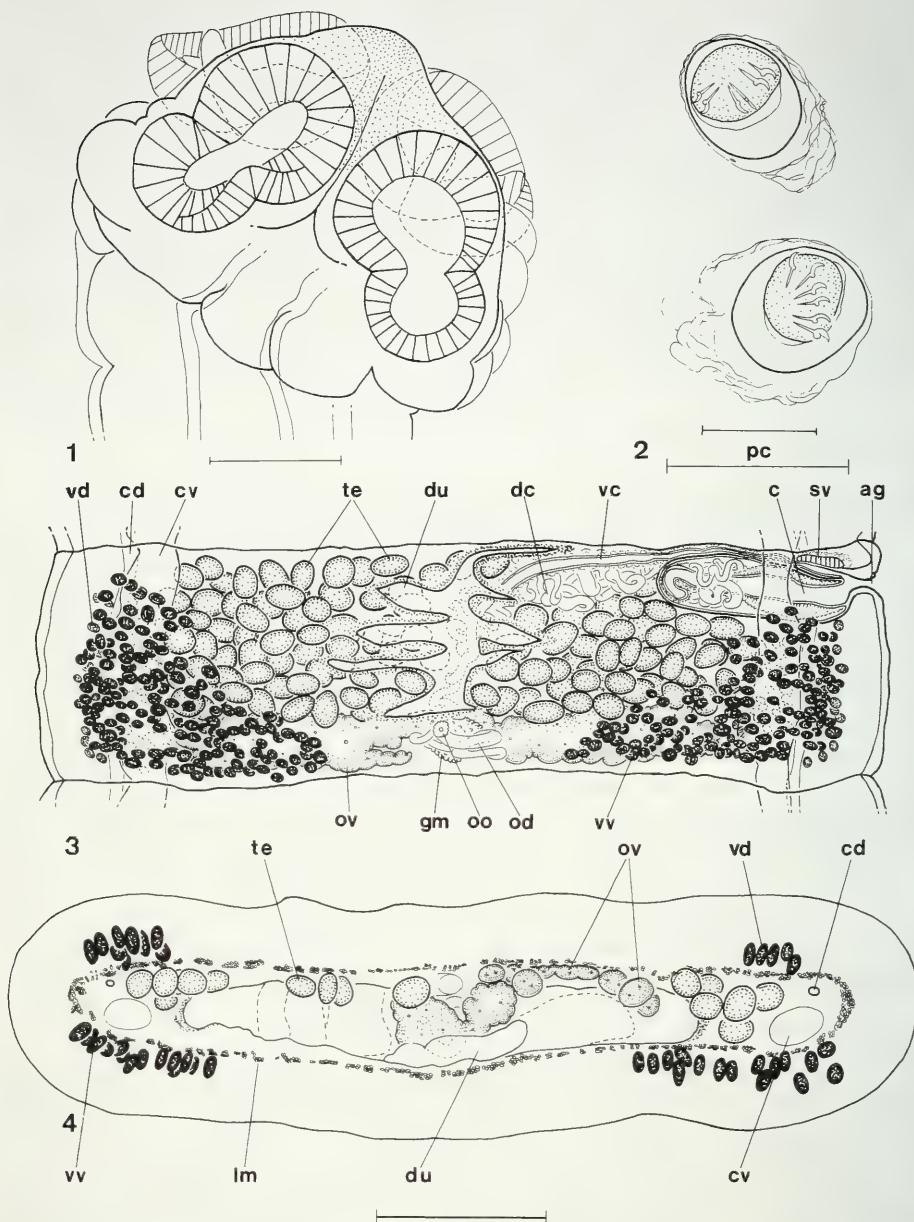
FIGS 1-4

Amphoteromorphus peniculus Diesing, 1850. 1. 19313 INVE, scolex pourvu de quatre grandes ventouses bilobées. Remarquer la concentration des cellules à cytoplasme granuleux à l'apex. 2. Croquis d'oeufs "in toto". 3. 19313 INVE, vue ventrale d'un proglottis mature. Ootype bien –visible 4. 22214 INVE, coupe transversale d'un proglottis mature. *Echelles:* 1 = 400 mm; 2 = 50 mm.; 3, 4 = 500 mm.

touses et longueur du scolex: 62-65 % (n = 3) (Fig. 1). Le lobe postérieur est 20-25 % plus petit que le lobe antérieur. Diamètre du petit lobe de 380-400 (n = 4), celui du grand lobe de 495-510 (n = 4). Concentration importante à l'apex de cellules à cytoplasme granuleux (Fig. 1). Musculature longitudinale interne constituée de faisceaux de fibres, avec concentration de ces faisceaux aux marges des proglottis. Canaux osmorégulateurs ventraux atteignant 65 de diamètre et chevauchant la poche du cirre dans sa partie terminale, parfois dans sa partie médiane. Canaux dorsaux d'un diamètre de 20-25 et passant dorsalement à la poche du cirre en position terminale ou subterminale. Paroi des canaux dorsaux plus épaisse que celle des ventraux.

Testicules médullaires ronds à ovoïdes, au nombre de 105-119 (x = 112, n = 11; MT = 100-136; n = 4), de 45-65 de diamètre, disposés souvent en trois couches et répartis plus ou moins uniformément entre les canaux osmorégulateurs ventraux, n'atteignant pas les canaux dorsaux et ventraux (Fig. 3).

Follicules vitellins corticaux formant deux bandes dorso-latérales et deux ventro-latérales triangulaires (Fig. 3). Rapport entre largeur des vitellogènes et largeur du proglottis: ventraux = 25-32 % (x = 30, n = 15); dorsaux = 10-20 % (x = 15, n = 15). Rapport entre longueur des vitellogènes et longueur du proglottis du côté poral: ventraux, 60-70 % (x = 65, n = 10); dorsaux, 57-71 % (x = 63, n = 10); du côté aporal: ventraux, 78-88 % (x = 82, n = 10); dorsaux, 75-89 % (x = 79, n = 10). Peu ou pas de follicules vitellins, ni de testicules dorsalement et ventralement à la poche du cirre.

Poche du cirre allongée, à paroi mince, longue de 295-350 (x = 330, n = 10), PC = 25-30 % (x = 26, n = 10; MT = 17-25, x = 22, n = 14)) (Fig. 3). Cirre occupant jusqu'à environ 70 % (n = 11) de la longueur de la poche du cirre. Pores génitaux irrégulièrement alternant, PG = 14-17 % (x = 16, n = 8; MT = 18-25, x = 22, n = 14). Vagin toujours antérieur à la poche (n = 74; MT = 65), pourvu d'un sphincter musculaire. Canal éjaculateur très contourné. Canal déférent également très contourné, atteignant le milieu du proglottis et le dépassant même dans certains cas.

Ovaire bilobé, large de 550-875 (x = 735, n = 10), occupant les 55-60 % (x = 57, n = 10; MT = 57-58, n = 3) de la largeur du proglottis.

Utérus pourvu de 4-8 (n = 20; MT = 4-7) diverticules utérins allongés latéralement (Fig. 3). Oncosphères de 19-21.5 (x = 20, n = 7) de diamètre, pourvues de crochets longs de 6.5-9 (n = 7.5; MT = 7.5-10, x = 9, n = 14); embryophore des oeufs mûrs de forme ronde à ovoïde (Fig. 2), d'un diamètre de 35-40 (x = 38, n = 7). Enveloppe externe hyaline, peu épaisse, très plissée et asymétrique.

REMARQUES

Fuhrmann (1934), révisant le matériel original de Diesing (1850), a observé un nombre de testicules plus élevé (120 à 160), contrairement à nos observations sur ce matériel type (100 à 136; x = 118), ce qui correspond aux observations concernant les spécimens récents (105-119, x = 112).

Woodland (1933a) redécrit *Amphoteromorphus peniculus*. A notre avis, cette redescription est fondée sur deux espèces mélangées. En raison du nombre figuré de testicules et de la disposition des vitellogènes (Figs 48-51), seule la figure 50 correspond à *A. peniculus*. Les figures 48, 49, 51 montrent un nombre nettement plus faible de testicules et des vitellogènes en position plus latérales ce qui correspond à

Amphoteromorphus piriformis (cf. Fig. 19). Cette conclusion est confirmée par la forme particulière de l'embryophore (Woodland, op.cit., Fig. 52) qui est exactement celle observée chez *A. piriformis* (Fig. 21). De plus, ces deux espèces vivent chez le même hôte.

Les pores génitaux de *A. peniculus* sont irrégulièrement alternes. Cette caractéristique est unique chez le genre *Amphoteromorphus* et différencie cette espèce de toutes les autres. Chez *Amphoteromorphus,* toutes les autres espèces du genre ont les pores génitaux unilatéraux ou considérés comme tels (de Chambrier & Vaucher, 1997). *A. peniculus* est l'espèce du genre qui possède le plus grand nombre de testicules dans le genre *Amphoteromorphus* (Tableau 1). De plus, cette espèce est bien reconnaissable à la taille de ses ventouses (Fig. 1). Ses vitellogènes ventraux sont plus étendus en direction du milieu du proglottis (Tableau 1 et Figs 3, 4) comme le relève déjà Fuhrmann (1934, p. 552). Enfin, il y a une importante concentration de cellules à cytoplasme granuleux à l'apex du scolex.

Amphoteromorphus parkamoo Woodland   Figs 5-11

Amphoteromorphus parkamoo Woodland, 1935: p. 214.

> *Hôte: Paulicea luetkeni* (Steindacher, 1877) (Pimelodidae); nom vernaculaire: Jaù.
> *Matériel examiné:* Brésil, Etat de Amazonas, Itacoatiara, INVE 19733, 25.09.92; 19852, 19.09.92; INVE 19851, 16.09.92; INVE 22085, 03.10.95; INVE 22240*, 08.10.95; INVE 22241*, 08.10.95; INVE 22242*, 11.10.95; INVE 22243*, 11.10.95; INVE 22244*, 11.10.95.
> *Localisation:* Intestin, partie antérieure.

DESCRIPTION

Strobiles acraspédotes, jusqu'à 50 mm de long, avec de nombreux plis tégumentaires transversaux et longitudinaux. Proglottis larges de 935-1300 (x = 1100, n = 15) et longs de 215-485 (x = 345, n = 10).

Scolex long de 690-1625 (x = 1275, n = 5), large de 1400-1960 (x = 1680, n = 6) et possédant une musculature longitudinale développée. Métascolex presque deux fois plus large que le cou (Fig. 5). Ventouses bilobées, longues de 430-665 (x = 520, n = 8) et pourvues d'une musculature radiaire puissante, avec une fine couche de muscles circulaires du côté interne (Fig. 6). Lobe antérieur de 220-360 de diamètre (x = 295, n = 7), légèrement plus large que le lobe postérieur: de 210-310 de diamètre (x = 270, n = 7). Rapport entre longueur des ventouses et longueur du scolex: 35-50 % (x = 40, n = 8) (Fig. 5). Musculature longitudinale interne constituée de faisceaux de fibres, avec concentration de ces faisceaux aux marges des proglottis (Figs 10, 11). Canaux osmorégulateurs ventraux chevauchant la poche du cirre dans son tiers terminal, de 10-15 de diamètre (Fig. 7). Canaux dorsaux d'un diamètre de 5 à 10, à paroi plus épaisse que celle des ventraux et passant dorsalement à la poche du cirre en position subterminale en général (Fig. 7).

Testicules médullaires, ronds à ovoïdes disposés en deux couches, exceptionnellement trois, au nombre de 34-48 (x = 41, n = 15), de 40-50 de diamètre, organisés en un champ avec une plus forte densité latéralement et atteignant les canaux osmorégulateurs ventraux et les follicules vitellins, mais sans les dépasser (Fig. 7). Peu ou pas de testicules chevauchant la poche du cirre.

Follicules vitellins corticaux et paramusculaires (Fig. 9) (dans 22 % des coupes), formant deux bandes dorso-latérales et deux bandes ventro-latérales. Rapport

TABLEAU I: Comparaison morphologique des six espèces du genre *Amphoteromorphus*.

Espèces	A. peniculus	A. parkamoo	A. piraeeba	A. piriformis sp. n.	A. ovalis sp. n.	A. ninoi sp. n.
Hôte(s)	*Brachyplatystoma flavicans*	*Paulicea luetkeni*	*Brachyplatystoma filamentosum*	*Brachyplatystoma flavicans*	*Brachyplatystoma* sp.	*B. vaillanti* et *B. filamentosum*
Rapport longueur des ventouses/longueur du scolex en "%"	62-65	35-50	25-45	30-45	40-55	30-45
Longueur du scolex en "µm"	1090	690-1625	1210-2525	730-1705	820-1800	930-1390
Largeur du scolex en "µm"	2275	1400-1960	2000-3740	1380-2435	980-2310	1360-2270
Largeur du proglottis	945-1425	935-1300	990-1425	1130-1385	915-1800	950-1850
Longueur du proglottis	475-655	215-485	275-365	165-270	74-172	100-135
Nombre de testicules	105-119 MT = 100-136	34-48	59-72	47-72	55-85	17-32
Follicules vitellins	corticaux (paramusculaires?)	corticaux (paramusculaires dans 22% des coupes)	corticaux (paramusculaires dans 15% des coupes)	corticaux (paramusculaires très rares)	corticaux (paramusculaires très rares)	corticaux (paramusculaires dans 75% des coupes)
Disposition des bandes ventro-latérales et dorso-latérales	chevauchement (mais les ventrales sont plus longues)	chevauchement	chevauchement	chevauchement	chevauchement	décalage
Rapport vit. ventraux/largeur progl. en "%"	25-32	18-20	18-25	15-24	18-23	10-20
longueur poche du cirre ("PC") (% largeur proglottis)	25-30 MT = 17-25	20-30	25-30	17-27	25-35	20-30
Pores génitaux	alternes	unilatéraux	unilatéraux	unilatéraux	unilatéraux	unilatéraux
Largeur ovaire (% largeur proglottis)	55-60 MT = 57-58	55-70	50-65	55-65	55-65	30-40
Nombre de diverticules utérins	4-8 MT = 4-7	3-5	3-6	3-6	4-7	2
Forme embryophore des oeufs mûrs	ovoïde à ronde	ronde	ronde	piriforme	ovoïde	ronde à ovoïde
longueur des crochets	6.5-9 MT = 7.5-10	5-8	6.5-8	5-6.5	6-7.5	6-8

Figs 5-9

Amphoteromorphus parkamoo Woodland, 1935. 5. 22085 INVE, scolex très plissé. 6. 27989 INVE, coupe sagittale d'un scolex montrant ses ventouses bilobées (flèche). 7. 22085 INVE, vue ventrale d'un proglottis mature. L'utérus n'est pas figuré. 8. Oeuf monté dans l'eau distillée. 9. 27989 INVE, coupe transversale partielle d'un proglottis gravide montrant la pénétration de quelques vitellogènes dans la médulla. *Echelles*: 5 = 300 mm; 6 = 100 mm; 7, 9 = 200 mm; 8 = 25 mm.

entre largeur des vitellogènes et largeur du proglottis: ventraux, 18-20 % (x = 19, n = 15); dorsaux, 16-19 % (x = 17, n = 15). Rapport entre longueur des vitellogènes et longueur du proglottis du côté poral: ventraux, 55-65 % (x = 60, n = 10); dorsaux, 54-
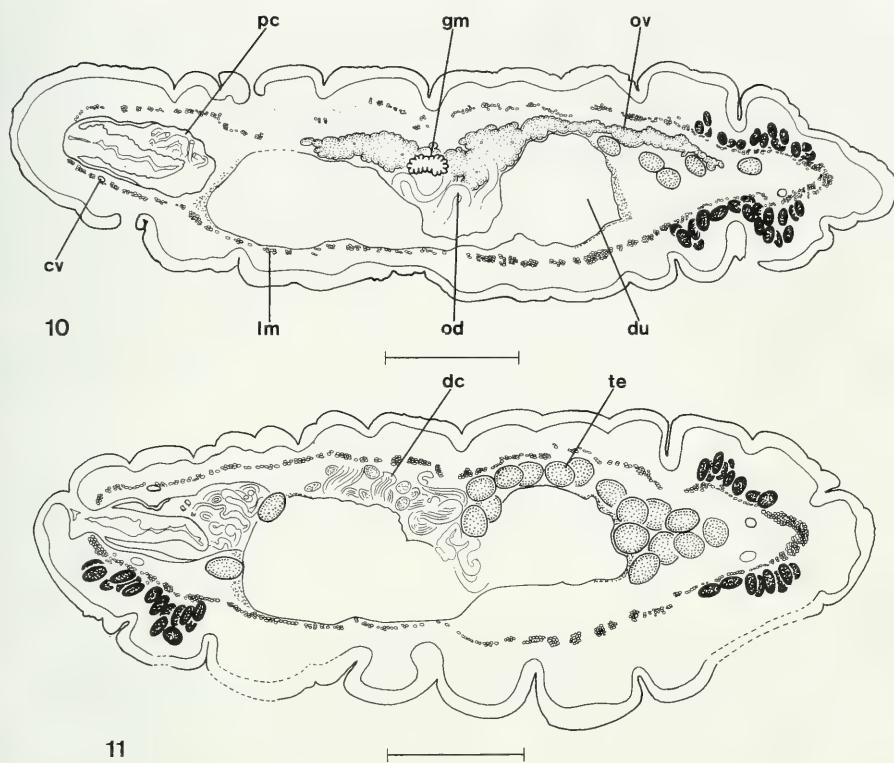
Figs 10-11

Amphoteromorphus parkamoo Woodland, 1935. 10. 27989 INVE, coupe transversale d'un proglottis prégravide, montrant la disposition de l'utérus et de l'ovaire. Glande de Mehlis bien visible. 11. 27989 INVE, coupe transversale d'un proglottis gravide, au niveau de l'utérus. Tégument très plissé. Musculature longitudinale interne plus dense aux marges du proglottis. *Echelles*: 10, 11 = 200 mm.

70 % (x = 56, n = 10); du côté aporal: ventraux, 76-87 % (x = 81, n = 10); dorsaux, 68-79 % (x = 74, n = 10). Peu ou pas de follicules vitellins dorsalement et ventralement à la poche du cirre (Fig. 7).

Poche du cirre allongée, à paroi mince, légèrement plus large dans sa partie porale, longue de 220-345 (x = 285, n = 11), PC = 20-30 % (x = 26, n = 20). Cirre occupant environ 60 % (n = 7) de la longueur de la poche du cirre (Fig. 7). Pores génitaux unilatéraux, PG = 16-21% (x = 18, n = 9). Vagin toujours antérieur à la poche du cirre (n = 65), avec un sphincter musculaire (Fig. 7). Canal éjaculateur très contourné. Canal déférent très contourné et dépassant le milieu du proglottis (Fig. 7).

Ovaire compact à contour irrégulier, large de 705-1415 (x = 1115, n = 10) et occupant les 55-70 % (x = 63, n = 10) du proglottis (Fig. 7).

Utérus occupant jusqu'à 70 % de la largeur des proglottis prégravides, avec 3-5 (n = 18) diverticules utérins peu allongés.

Oncosphères de 15-16 (x = 15, n = 9) de diamètre, pourvues de crochets longs de 5-8 (x = 7, n = 17); embryophore des oeufs mûrs de forme ronde, divisée en 2 couches. Diamètre de la couche externe de 25-34 (x = 29, n = 9). Enveloppe externe hyaline, peu épaisse, très plissée, asymétrique et longue de 48-80 (x = 57, n = 9)   (Fig. 8).

ANALYSE GÉNÉTIQUE (Tableau 2 et Fig. 37)

Sur les 5 échantillons étudiés, six systèmes enzymatiques ont fourni des zymogrammes dont les mobilités électrophorétiques sont clairement interprétables. Seul l'échantillon INVE 22243 a démontré une faible activité au locus ALD, avec un seul phénotype enzymatique. Aux loci AAT, ACP, AK, ALD, MDH et PGM, les zymogrammes présentent un seul phénotype enzymatique. Deux allèles existent au locus PGI. A. parkamoo se distingue sur la base des izoenzymes de A. ovalis et A. ninoi, mais pas de A. piraeeba ni de A. piriformis.

REMARQUE

A. parkamoo se différencie de A. peniculus par ses pores génitaux unilatéraux. En revanche, il est proche de A. piraeeba.

Amphoteromorphus piraeeba Woodland   Figs 12-16

Amphoteromorphus piraeeba Woodland, 1934: 274.
Amphoteromorphus peniculus sensu Woodland, 1933: 189.
Amphoteromorphus piraeeba; de Chambrier & Vaucher, 1997: 231.

Hôte: Brachyplatystoma filamentosum (Lichtenstein) (Pimelodidae); nom vernaculaire: Piraìba.
Matériel examiné: Brésil, Etat de Amazonas, Itacoatiara, INVE 19659, 15.09.92; INVE 19660, 17.09.92; INVE 19661, 25.09.92; INVE 22069, 21.10.95; INVE 22070, 15.10.95; 02.10.95; INVE 22221; INVE 22223*; INVE 22225*; INVE 22227; INVE 22228; INVE 22232; INVE 22234; INVE 22235; INVE 22236; INVE 22237; INVE 22239*; 13.10.92; INVE 22242; 16.10.92; INVE 22251*; INVE 22252; INVE 22253; 20.10.95.
Localisation: Intestin.

DESCRIPTION

Strobiles acraspédotes, jusqu'à 65 mm de long. Tégument plissé. Proglottis matures et gravides larges de 990-1425 (x = 1120, n = 22) et longs de 275-365 (x = 330, n = 10).

Scolex long de 1210-2525 (x = 1780, n = 8) et large de 2000-3740 (x = 2920, n = 8). Métascolex plissé et environ deux fois plus large que le cou (Fig. 12). Ventouses bilobées, pourvues d'une musculature radiaire puissante, longues de 495-650 (x = 560, n = 9). Lobe antérieur de 290-400 de diamètre (x = 355, n = 12), légèrement plus large que le lobe postérieur: 260-390 de diamètre (x = 330, n = 9). Rapport entre longueur des ventouses et longueur du scolex: 25-45 % (x = 35, n = 10) (Fig. 12). Présence de cellules à cytoplasme granuleux en faible quantité, toujours situées à l'apex du scolex (Fig. 12). Musculature longitudinale interne constituée de faisceaux de fibres, avec concentration de ces faisceaux aux marges des proglottis (Figs. 14, 16). Canaux osmorégulateurs ventraux de 10-20 de diamètre, chevauchant la poche du cirre dans sa partie subterminale. Canaux osmorégulateurs dorsaux de 8-12 de diamètre, à paroi plus
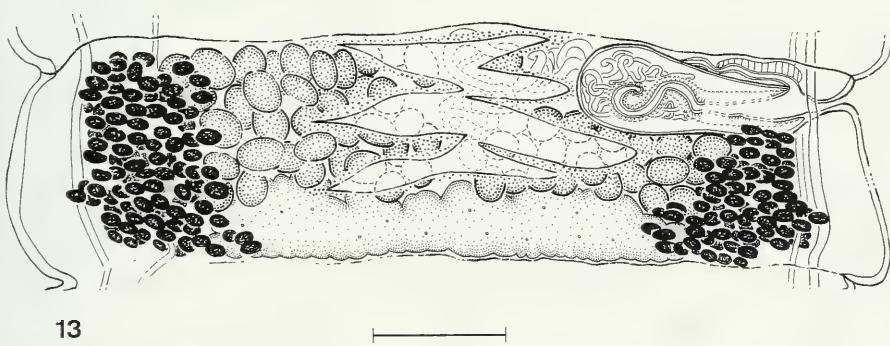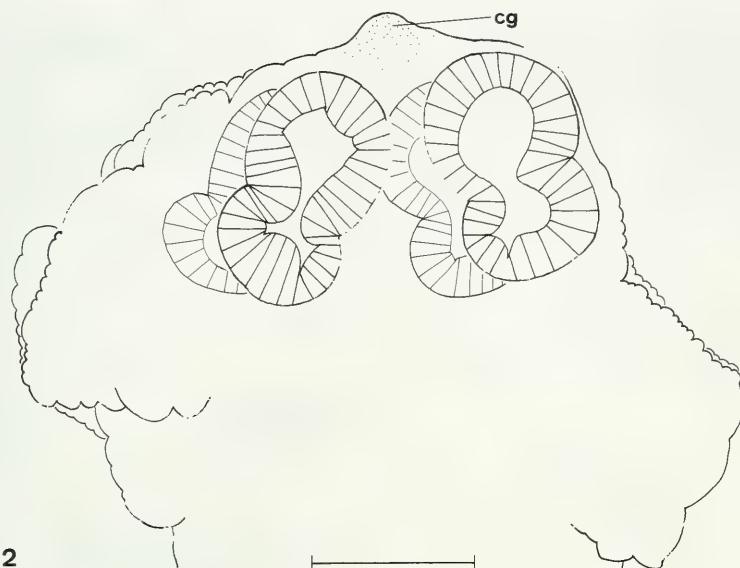
Figs 12-13

Amphoteromorphus piraeeba Woodland, 1934. 12. 22249 INVE, scolex; 13. 19659 INVE, vue ventrale d'un proglottis mature. *Echelles*: 12 = 500 mm; 13 = 200 mm.

épaisse que celle des ventraux et croisant également la poche du cirre dans sa partie subterminale (Fig. 13).

Testicules médullaires, ronds à ovoïdes, disposés en deux ou trois couches, au nombre de 59-72 (x = 66, n = 15), de 60-100 de diamètre et organisés en un champ dans les proglottis prématures. Disposition en deux champs dans les proglottis prégravides et gravides, atteignant parfois les canaux osmorégulateurs dorsaux mais jamais les canaux ventraux (Fig. 13).

Vitellogènes corticaux et paramusculaires (dans 15 % des coupes), formant deux bandes dorso-latérales et chevauchant les deux ventro-latérales. Follicules vitellins dorsaux et ventraux atteignant les canaux dorsaux et en général les canaux ventraux. Rapport entre largeur des vitellogènes et largeur du proglottis, ventraux:
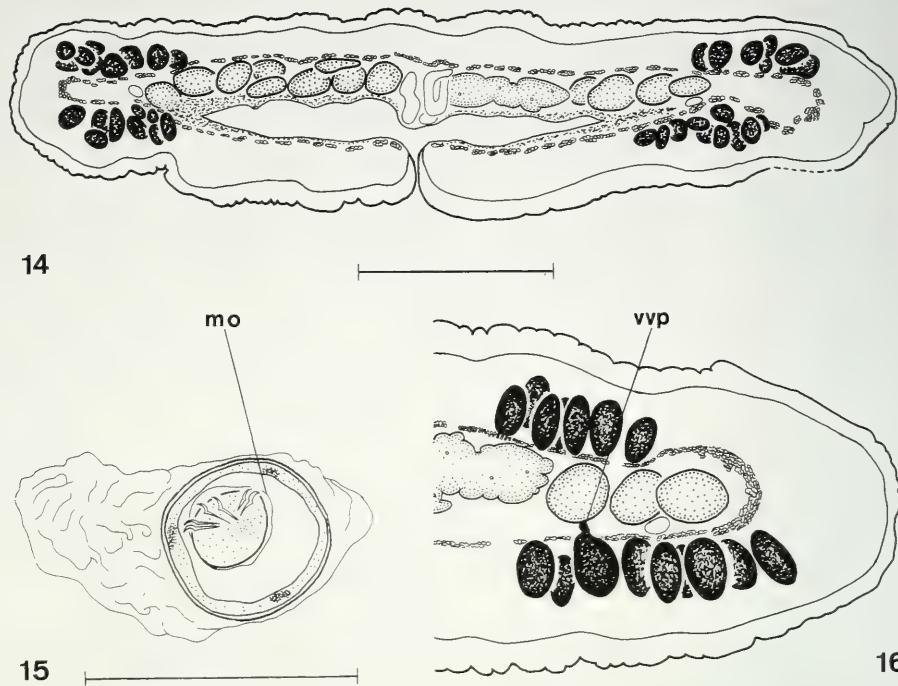
FIGS 14-16

Amphoteromorphus piraeeba Woodland, 1934. 14. 19659 INVE, coupe transversale montrant la position dorso-ventrale des vitellogènes. 15. 21983 INVE, oeuf monté dans l'eau distillée; 16. 19659 INVE, coupe transversale partielle d'un proglottis mature montrant la pénétration d'un vitellogène dans la musculature longitudinale interne. *Echelles:* 14 = 500 mm; 15 = 50 mm; 16 = 100 mm.

18-25 % (x = 21, n = 15); dorsaux: 17-26 % (x = 20, n = 15). Rapport entre longueur des vitellogènes et longueur du proglottis, du côté poral: ventraux, 55-80 % (x = 65, n = 10); dorsaux, 53-78 % (x = 64, n = 10); du côté aporal: ventraux, 85-93 % (x = 89, n = 10); dorsaux, 81-90 % (x = 88, n = 10).

Poche du cirre allongée, à paroi mince, longue de 230-390 (x = 275, n = 11), PC = 25-30 % (x = 27, n = 11). Cirre occupant jusqu'à environ 60 % de la longueur de la poche du cirre (Fig. 12). Pores génitaux unilatéraux, PG = 12-18 (x = 15, n = 9). Vagin toujours antérieur à la poche du cirre (x = 60), avec un sphincter musculaire. Canal éjaculateur très contourné (Fig. 13). Canal déférent également très contourné et atteignant le milieu du proglottis.

Ovaire compact, à contour irrégulier, large de 625-860 (x = 735, n = 11), occupant les 50-65 % (x = 60, n = 10) de la largeur du proglottis.

Utérus pourvu de 3-6 (n = 25) diverticules utérins allongés et minces.

Oncosphères de 14-17 (x = 15.5, n = 7), pourvues de crochets longs de 6.5-8 (x = 7, n = 6) (Fig. 15); embryophore des oeufs mûrs de forme ronde, divisée en 2

couches. Diamètre de la couche externe de 29-32 (x = 30, n = 4). Enveloppe externe hyaline, peu épaisse, très plissée, asymétrique et longue de 54-74 (x = 60, n = 4) (Fig. 15).

ANALYSE GÉNÉTIQUE (Tableau 2 et Fig. 37)

Sur les 3 échantillons étudiés, les zymogrammes présentent un phénotype enzymatique unique aux loci AAT, ACP, AK, MDH et PGI. ALD exprime deux allèles dans un cas. Un exemplaire présente une deuxième tache de très faible activité au locus PGM, que nous n'avons pas prise en considération.

Les loci NP et HK ne semblent pas être exprimés. Cependant, au locus HK, quelques taches parasites apparaissent qui expriment peut-être l'activité d'une autre enzyme (GCDH) (cf. Hillis *et al.*, 1996). *A. piraeeba* se distingue sur la base des izoenzymes de *A. ovalis* et *A. ninoi* mais pas de *A. parkamoo*, ni de *A. piriformis*.

REMARQUES

Certaines de nos observations diffèrent de ceux de Woodland (1934, p. 274) qui décrit chez *A. piraeeba* un nombre de testicules par proglottis de trois à quatre fois supérieur: 200 au lieu de 59 à 72. Woodland (1934, p. 274) observe une position postérieure ou antérieure du vagin. Nous constatons que ce dernier débouche toujours antérieurement à la poche du cirre.

A. piraeeba et *A. parkamoo* sont deux espèces voisines morphologiquement et anatomiquement. Plusieurs critères toutefois permettent de les différencier (Tableau 1). Le scolex de *A. piraeeba* est plus large, plus long, ses testicules sont plus nombreux (59 à 72 contre 34 à 48 chez *A. parkamoo*) et d'un diamètre supérieur, son sphincter musculaire, entourant le vagin, paraît moins développé.

La figure 16 montre un décalage des vitellogènes ventraux et dorsaux, mais ne constitue pas un caractère taxonomique.

Amphoteromorphus piriformis sp. n.   Figs 17-21, 35, 36

Amphoteromorphus piraeeba Woodland, 1934: 274.
Amphoteromorphus peniculus sensu Woodland, 1933: 189.
Amphoteromorphus piraeeba; de Chambrier & Vaucher, 1997: 231.
Amphoteromorphus peniculus; Rego, Chubb & Pavanelli, 1999: 251.

Hôte: *Brachyplatystoma flavicans* (Lichtenstein) (Pimelodidae); nom vernaculaire: Dourada.

Matériel examiné: Etude morpho-anatomique: Brésil, Etat de Amazonas, Itacoatiara, holotype INVE 32923, 3 paratypes INVE 32922, 32924-25, 13.09.92; INVE 19310, 16.09.92; INVE 19311, 13.09.92; INVE 19312, 17.09.92; INVE 19314, 21.09.92; INVE 19320, 17.09.92; INVE 19326, 17.09.92; INVE 19624, 15.09.92; INVE 19651*, 21.09.92; INVE 22198*, 30.09.95; INVE 22199*, 30.09.95; INVE 22200*, 30.09.95; INVE 22208, INVE 22209*, INVE 22210*, INVE 22211*, 21.09.92; INVE 22229*, 07.10.95; INVE 27432, 06.10.95.

Localisation: Intestin antérieur.

DESCRIPTION

Strobiles acraspédotes, jusqu'à 50 mm de long. Tégument très plissé. Proglottis matures et gravides larges de 1130-1385 (x = 1240, n = 20) et longs de 165-270 (x = 225, n = 15).

Scolex long de 730-1705 (x = 1190, n = 9), large de 1380-2435 (x = 1905, n = 9) et possédant une musculature longitudinale bien développée. Métascolex plissé et

TABLEAU **II**: Zymogrammes de neuf systèmes enzymatiques

Espèces	Hôtes	AAT	ACP	AK	ALD	MDH	PGI	PGM	HK	NP
A. parkamoo	Paulicea luetkeni	AATb	ACPb	AKb	ALDa	MDHb	PGIa ou b	PGMa	–	–
A. piraeeba	B. filamentosum	AATb	ACPb	AKb	ALDa ou b	MDHb	PGIb	PGMa,b	–	–
A. piriformis	B. flavicans	AATb	ACPb	AKb	ALDa	MDHb ou d?	PGIb	PGMa	–	–
A. ovalis	Brachyplatystoma sp.	AATc	ACPb	AKa	–	MDHa,b,c	PGIb	PGMb,d	HKb	NPa
A. ninoi	B. filamentosum	AATa	ACPa ou b ou c	AKb	ALDa	MDHa	PGIa	PGMa,b,c	HKa	–
A. ninoi	B. vaillanti	AATa	ACPa	AKb	ALDb	MDHa	PGIa	PGMb	HKc	–
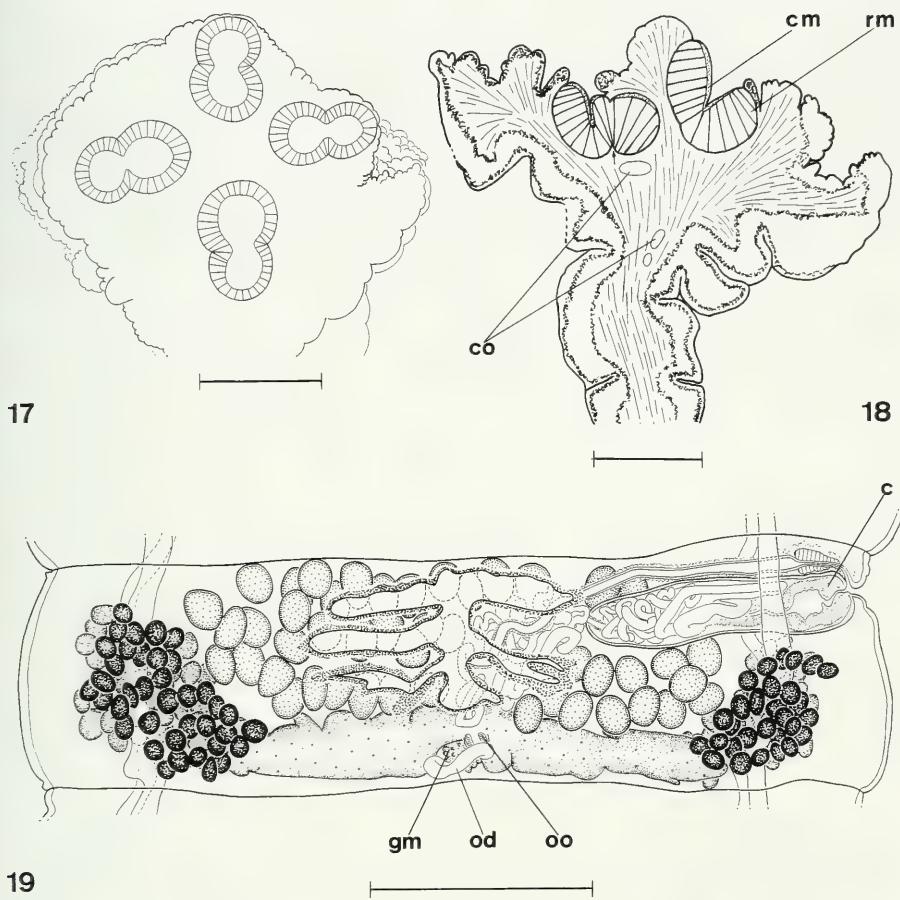
FIGS 17-19

Amphoteromorphus piriformis sp. n. 17. 19310 INVE, scolex; 18. Paratype 32922 INVE, coupe sagittale d'un scolex; 19. holotype 32923 INVE, vue ventrale d'un proglottis mature. *Echelles*: 17 = 600 mm; 18 = 300 mm; 19 = 250 mm.

environ deux fois plus large que le cou (Fig. 35). Ventouses bilobées (Figs 17, 18, 36), longues de 340-750 (x = 510, n = 11) et pourvues d'une musculature radiaire puissante, avec une fine couche de muscles circulaires du côté interne (Fig. 18). Lobe antérieur de 195-405 (x = 300, n = 10) étant légèrement plus large que le lobe postérieur: 185-335 (x = 270, n = 10). Rapport entre longueur des ventouses et longueur du scolex: 30-45% (x = 35, n = 10) (Fig. 17). Musculature longitudinale interne constituée de faisceaux de fibres, avec concentration de ces faisceaux aux marges des proglottis (Fig. 20). Canaux osmorégulateurs ventraux chevauchant la poche du cirre dans son tiers terminal, de 25-45 de diamètre. Canaux dorsaux d'un diamètre de 10-20, à paroi plus épaisse et passant également sous la poche dans sa partie terminale (Fig. 19).

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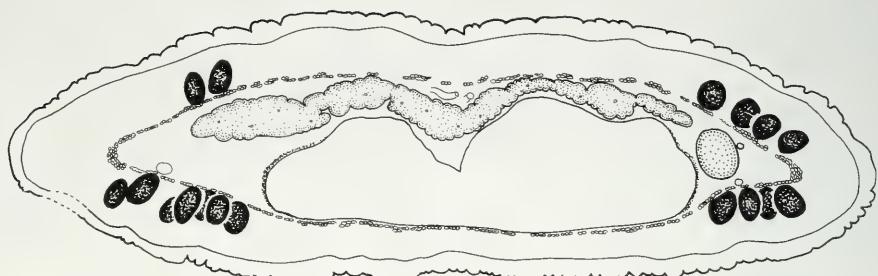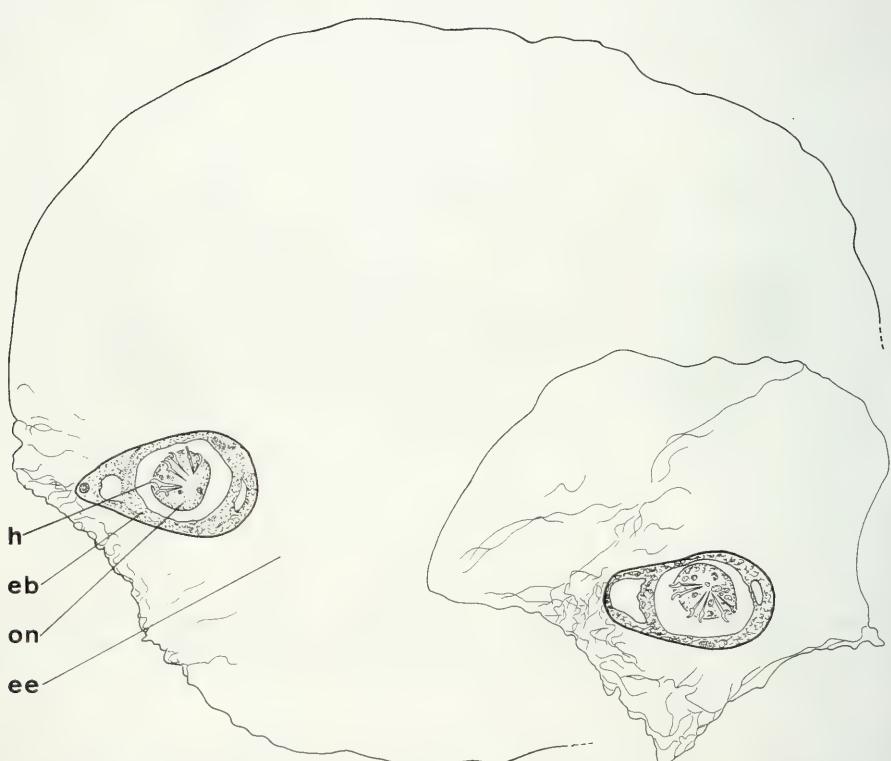
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Figs 20-21

Amphoteromorphus piriformis sp. n. 20. 19310 INVE, coupe transversale d'un proglottis mature; 21. 19311 INVE, œufs montés dans l'eau distillée. *Echelles*: 20 = 200 mm; 21 = 50 mm.

Testicules médullaires, ronds à ovoïdes, disposés en deux couches, parfois trois, au nombre de 47-72 (x = 56, n = 15), de 40-60 de diamètre et organisés en un champ avec une plus forte densité latéralement, n'atteignant, en général, pas les canaux

osmorégulateurs dorsaux, mais parfois les canaux ventraux (Fig. 19). Testicules présents dorsalement à la poche du cirre.

Follicules vitellins corticaux, parfois paramusculaires, formant deux bandes dorso-latérales et deux ventro-latérales (Fig. 20). Rapport entre largeur des vitellogènes et largeur du proglottis: ventraux = 15-24 % (x = 17, n = 32); dorsaux = 18-23 % (x = 18, n = 15). Rapport entre longueur des vitellogènes et longueur du proglottis, du côté poral: ventraux, 56-66 % (x = 60, n = 10); dorsaux, 50-70 % (x = 57, n = 10); du côté aporal: ventraux, 73-85 % (x = 78, n = 10); dorsaux, 59-83 % (x = 72, n = 10). Peu ou pas de follicules vitellins dorsalement et ventralement à la poche de cirre   (Fig. 19).

Poche du cirre allongée, à paroi mince, longue de 200-325 (x = 285, n = 14), PC = 17-27 % (x = 23, n = 15). Cirre occupant environ 60 % de la longueur de la poche du cirre (Fig. 19). Pores génitaux unilatéraux, PG = 13-23 % (x = 17, n = 8). Vagin toujours antérieur à la poche du cirre (n = 75), avec un sphincter musculaire sub-terminal (Fig. 19). Canal éjaculateur très contourné. Canal déférent également très contourné et atteignant le milieu du proglottis (Fig. 19).

Ovaire compact à contour irrégulier, parfois bilobé, large de 670-900 (x = 750, n = 10) et occupant les 55-65 % du proglottis (x = 60, n = 10). Utérus pourvu de 3-6 diverticules utérins (n = 20) (Fig. 19), contenant de nombreux oeufs avec une faible proportion d'oeufs mûrs.

Oncosphères de 12-14.5 (x = 13.5, n = 9) de diamètre, pourvues de crochets longs de 5-6.5 (x = 6, n = 13); embryophore des oeufs mûrs de forme piriforme (les embryophores des oeufs non mûrs sont de formes rondes), long de 28-33 (x = 30, n = 7) et large de 21-30 (x = 24.5, n = 7) (Fig. 20). Enveloppe externe hyaline, peu épaisse, très plissée, asymétrique et longue de 40-64 (x = 47.5, n = 8) (Fig. 21).

ANALYSE GÉNÉTIQUE (Tableau 2 et Fig. 37)

Sept systèmes enzymatiques ont fourni des zymogrammes présentant des mobilités électrophorétiques clairement interprétables. Aux loci AAT, ACP, AK, ALD, PGI, PGM, les zymogrammes présentent un seul phénotype enzymatique. MDH présente deux allèles. Les loci HK et NP ne semblent pas exprimés.

A. piriformis se distingue sur la base des izoenzymes de *A. ovalis* et *A. ninoi* mais pas de *A. parkamoo*, ni de *A. piraeeba*.

REMARQUES

A. piriformis est placé dans le genre *Amphoteromorphus* en raison de la présence d'un métascolex, d'un scolex pourvu de quatre ventouses bilobées, d'une absence d'organe apical, de proglottis acraspédotes, de vitellogènes principalement corticaux et de pores génitaux unilatéraux (avec quelques alternances irrégulières possibles).

A. piriformis présente des embryophores piriformes, qui le différencie de toutes les autres espèces (Fig. 21). Parmi elles, *A. piraeeba* est la plus proche.

Les résultats du présent travail conduisent à revoir les conclusions de de Chambrier & Vaucher (1997): l'oeuf figuré (Fig. 15) n'appartient pas à *A. piraeeba* mais bien à *A. piriformis* qui n'avait pas été séparé spécifiquement. Les auteurs figurent

deux dessins (Figs 13 et 15) qui ne correspondent pas à *A. piraeeba*, mais à *A. piri-formis*. En outre, p. 229 (op. cit.), les hôtes dans la Table 1 sont intervertis : l'hôte de *A. peniculus* Diesing, 1850 et de *A. peniculus* sensu Woodland (1933a) étant *B flavi-cans*, celui de *A. piraeeba* Woodland, 1934 *B. filamentosum*.

En plus des oeufs, certains caractères discrets permettent de différencier *A. pir-iformis* de *A. piraeeba* (Tableau 1): le scolex de *A. piriformis* est plus petit, ses ven-touses sont légèrement moins longues (510 au lieu de 560 en moyenne), ses proglottis sont plus larges (1240 au lieu de 1120 en moyenne), mais moins longs (225 au lieu de 330 en moyenne), ses testicules ont un diamètre moins important (40-60 au lieu de 60-100) et sont moins nombreux en moyenne (56 au lieu de 66) et le rapport PC est un peu moins élevé (17-27 % au lieu de 25-30%). En conséquence, nous sommes en présence d'une nouvelle espèce que nous appelons *A. piriformis* en référence à la forme particulière de ses embryophores.

L'électrophorèse des protéines ne nous permet pas de distinguer ces deux espèces.

Amphoteromorphus ovalis sp. n.   Figs 22-27

Hôte: Brachyplatystoma sp. (Pimelodidae); nom vernaculaire: filhote da capa preta.
Matériel examiné: Brésil, Etat de Amazonas, Itacoatiara 13.10.95: holotype INVE 22247, 2 paratypes INVE 22249-50, INVE 21742, INVE 22247, INVE 22248, INVE 22249*, INVE 22250.
Localisation: Intestin, dans le sixième antérieur.

DESCRIPTION

Strobiles acraspédotes, avec de nombreux plis tégumentaires transversaux et longitudinaux aux vers. Proglottis larges de 916-1800 (x = 1525, n = 27) et longs de 74-172 (x = 135, n = 25).

Scolex long de 820-1800 (x = 1345, n = 7), large de 980-2310 (x = 1925, n = 7) et possédant une musculature longitudinale développée. Ventouses bilobées, longues de 525-745 (x = 650, n = 14) et pourvues d'une musculature radiaire puissante (Fig. 22). Lobe antérieur de 305-500 de diamètre (x = 420, n = 14), légèrement plus large que le lobe postérieur: de 245-425 de diamètre (x = 360, n = 14). Rapport entre longueur ventouses et longueur du scolex: 40-55 % (x = 45, n = 8) (Fig. 22). Musculature longitudinale interne constituée de faisceaux de fibres, avec concentration de ses faisceaux aux marges des proglottis (Fig. 27). Canaux osmorégulateurs ventraux chevauchant la poche du cirre dans son tiers terminal, de 100-300 de diamètre. Canaux dorsaux d'un diamètre de 7 à 10, à paroi plus épaisse que celle des ventraux et tra-versant également la poche du cirre dans son tiers terminal (Fig. 26).

Testicules médullaires, ronds à ovoïdes disposés en deux couches, parfois trois, au nombre de 55-85 (x = 71, n = 22), de 30-50 de diamètre, organisés en un champ, deux dans les proglottis gravides (Figs 23, 26).

Follicules vitellins principalement corticaux, formant deux bandes dorso-latérales et deux bandes ventro-latérales (Fig. 27). Rapport entre largeur des vitello-gènes et largeur du proglottis: ventraux: 18-23 % (x = 20, n = 16); dorsaux: 19-26 % (x = 23, n = 17). Rapport entre longueur des vitellogènes et longueur du proglottis: du côté poral: ventraux, 56-79 % (x = 68, n = 20); dorsaux, 60-80 % (x = 72, n = 20); du côté aporal: ventraux, 78-91 % (x = 83, n = 20); dorsaux, 76-87 % (x = 80, n = 15).
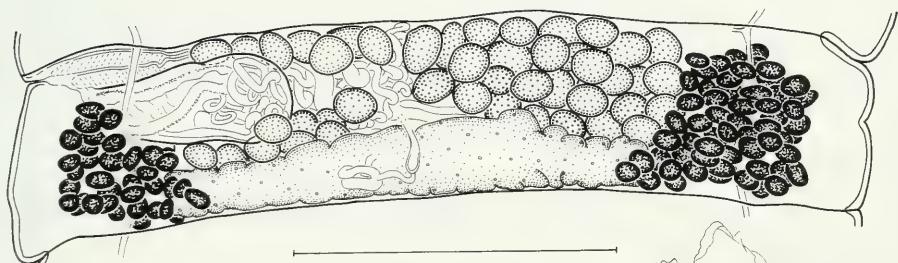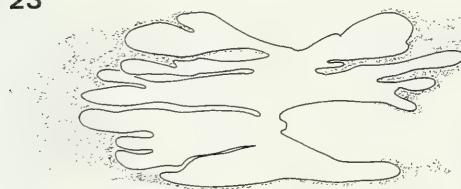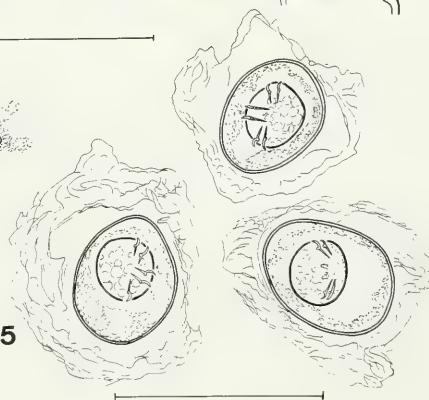
FIGS 22-25

Amphoteromorphus ovalis sp. n. 22. Paratype 22249 INVE, scolex. 23. Holotype 22247 INVE, vue dorsale d'un proglottis mature. 24. Holotype 22247 INVE, détail de l'utérus montrant ses diverticules ramifiés, ainsi que la présence de cellules chromophiles à leur extrémité. 25. 21742 INVE, œufs montés dans l'eau distillée. *Echelles:* 22 = 500 mm; 23, 24 = 250 mm; 25 = 50 mm.

Poche du cirre allongée, à paroi mince (Fig. 26). Rapport entre longueur de la poche du cirre et largeur du proglottis, PC = 25-35 % (x = 28, n = 22). Cirre allongé, très contourné, à paroi mince et occupant jusqu'à 70% (n = 22) de la longueur de la PC (Fig. 26). Pores génitaux unilatéraux. Vagin toujours antérieur à la poche du cirre (n = 75), pourvu d'un sphincter musculaire bien développé. Canal éjaculateur très contourné (Fig. 26). Canal déférent très contourné également et dépassant le milieu du proglottis.

Ovaire compact à contour irrégulier occupant les 55-65 % (x = 59, n = 28) du proglottis (Fig. 23).

Utérus pourvu de 4-7 (n = 20) diverticules utérins (Fig. 24).

Oncosphères de 13-16 (x = 14.5, n = 7) de diamètre, pourvues de crochets longs de 6-7.5 (n = 12); embryophore des oeufs mûrs de forme ovoïde , long de 32-37 (x = 33.5, n = 8) et large de 25-27 (x = 26, n = 8) (Fig. 20). Enveloppe externe hyaline, peu épaisse, très plissée, asymétrique et longue de 65-70 (ou plus) (Fig. 25).

ANALYSE GÉNÉTIQUE (Tableau 2 et Fig. 37)

Un seul échantillon a été analysé et ses mobilités électrophorétiques sont interprétables dans huit systèmes enzymatiques: AAT, ACP, AK, MDH, PGI, PGM, HK et NP. Cette nouvelle espèce possède des mobilités électrophorétiques totalement différentes aux loci AAT et AK. Cette espèce est également la seule à afficher trois phénotypes enzymatiques au locus MDH. Au locus HK, *Amphoteromorphus ovalis* se distingue de *A. ninoi* seulement, le locus n'étant pas exprimé dans les autres échantillons. Au locus PGM, *A. ovalis* présente un phénotype enzymatique qui n'a pas d'équivalent dans les autres échantillons. Il est le seul également à présenter une réaction au locus NP. Ces résultats suggèrent que *A. ovalis* est un taxon distinct.

REMARQUES

Amphoteromorphus ovalis se distingue de *A. peniculus* et de *A. parkamoo* par le nombre de testicules (Tableau 1) et de *A. piriformis* par la forme ovoïde de ses embryophores.

A. ovalis est très proche de *A. piraeeba*. Certains caractères permettent tout de même de les différencier (Tableau 1): chez *A. ovalis*, le scolex est nettement plus petit, les proglottis sont notablement plus larges et moins longs. Ses ventouses sont plus longues et ses testicules, d'un diamètre inférieur, sont plus nombreux. La forme de ses embryophores est ovoïde, alors qu'ils sont ronds chez *A. piraeeba*. Chez *A. ovalis*, le sphincter vaginal est plus développé. Par ailleurs, le canal éjaculateur et le canal déférent sont plus contournés que dans les autres espèces.

Sur la base de l'analyse génétique par électrophorèse des protéines, *A. ovalis* se différencie des autres espèces par trois systèmes enzymatiques. En conséquence, *A. ovalis* représente une nouvelle espèce qui est nommée *ovalis* en raison de la forme de ses embryophores.

L'identification de l'hôte de *A. ovalis* pose problème. John G. Lundberg (Philadelphia) (communication personnelle) déduit de plusieurs photographies qu'il ne s'agit pas de *Brachyplatystoma filamentosum* ("piraìba"), mais d'un poisson vraisemblablement distinct appelé à Belem " filhote da capa preta ".
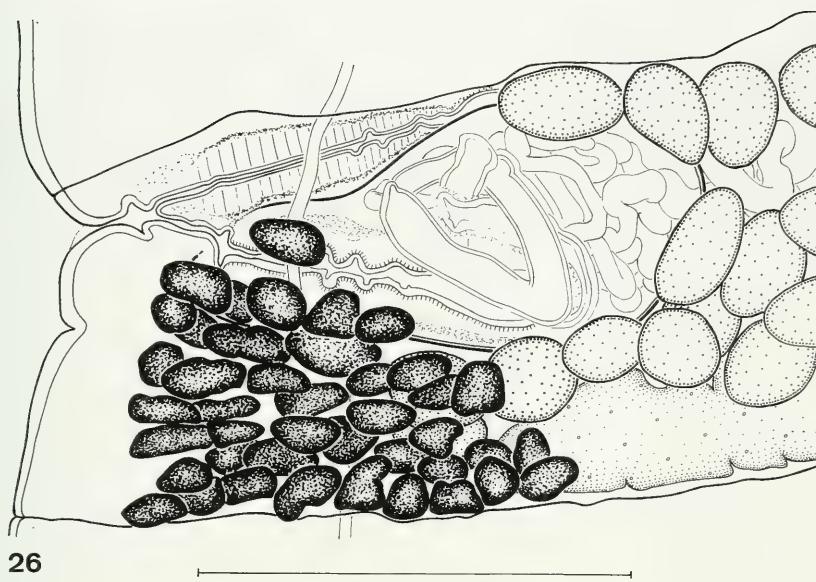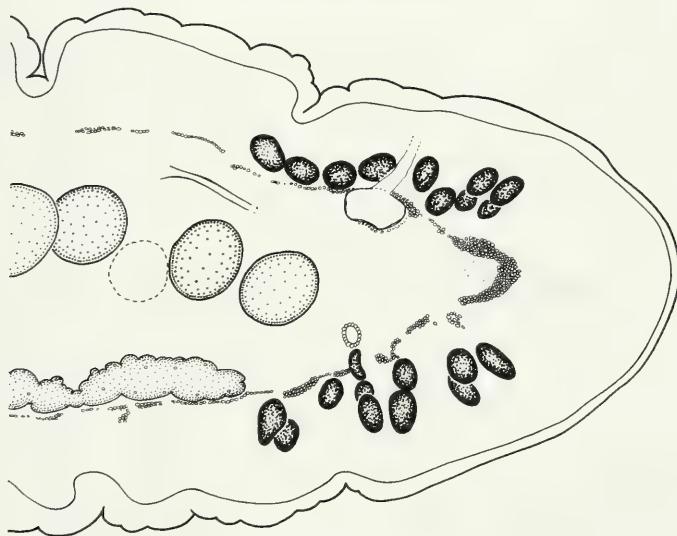
FIGS 26-27

Amphoteromorphus ovalis sp. n. 26. Holotype 22247 INVE, vue dorsale du vagin et de la poche du cirre. 27. 21742 INVE, coupe transversale partielle d'un proglottis mature. *Echelles*: 26 = 100 mm; 27 = 250 mm.

Amphoteromorphus ninoi sp. n.   Figs 28-34

Hôte-type: Brachyplatystoma vaillanti (Valenciennes, 1840) (Pimelodidae); nom ver-
naculaire: Piramutaba.

Autre hôte: B. filamentosum (Lichtenstein); nom vernaculaire: Piraìba.

Matériel examiné: Etude morpho-anatomique: Brésil, Etat de Amazonas, Itacoatiara, de
Brachyplatystoma vaillanti, 02.10.92: holotype INVE 22203, 3 paratypes INVE 32927-28,
32859; INVE 22201; INVE 22202; INVE 22204; INVE 22205; INVE 22206*; INVE 22207*.
De *Brachyplatystoma filamentosum,* 02.10.95: INVE 22232, INVE 22234, INVE 22235*, INVE
22236*, INVE 22237*; INVE 22239*.

Localisation: Intestin, partie antérieure.

DESCRIPTION

Strobiles acraspédotes, jusqu'à 35 mm de long. Tégument peu ou pas plissé.
Proglottis larges de 950-1850 (x = 1340, n = 50) et longs de 100-135 (x = 115, n = 15).

Scolex long de 930-1390 (x = 1110, n = 10), large de 1360-2270 (x = 1950, n
= 10) et possédant une musculature longitudinale très développée. Métascolex plissé,
une fois et demi à deux fois plus large que le cou. Ventouses bilobées (Figs 28, 29),
longues de 305-435 (x = 375, n = 15), pourvues d'une musculature radiaire puissante
et d'une fine couche de muscles circulaires du côté interne (Fig. 29). Lobe antérieur de
195-400 de diamètre (x = 290, n = 15), légèrement plus large que le lobe postérieur:
160-270 de diamètre (x = 220, n = 11). Rapport entre longueur des ventouses et
longueur du scolex: 30-45 % (x = 35, n = 10) (Fig. 28). Présence de cellules à cyto-
plasme granuleux situées à l'apex du scolex (Fig. 28). Musculature longitudinale in-
terne développée et constituée de faisceaux denses (Figs 32-34). Concentration de ces
faisceaux aux marges des proglottis. Canaux osmorégulateurs ventraux chevauchant la
poche du cirre dans sa partie médiane, de 25-35 de diamètre (Fig. 30). Canaux dorsaux
de 15-20 de diamètre, à paroi plus épaisse que celle des ventraux, chevauchant la poche
dans son tiers proximal (Fig. 30).

Testicules médullaires, ronds à ovoïdes, disposés en deux couches, exception-
nellement trois, au nombre de 17-32 (x = 24, n = 40), organisés en un champ, avec une
plus forte densité latéralement, de 40-65 de diamètre, atteignant et dépassant parfois les
canaux osmorégulateurs ventraux. Testicules dépassant parfois les vitellogènes
ventraux, mais jamais les dorsaux (n = 30) et présents dorsalement à la poche du cirre
(Fig. 30).

Follicules vitellins corticaux, paramusculaires dans 75 % des coupes ou rare-
ment médullaires (Figs 32-34). Follicules vitellins formant deux bandes dorso-
latérales, décalées par rapport aux deux autres bandes ventro-latérales (Figs 30,32).
Rapport entre largeur des vitellogènes et largeur du proglottis: ventraux, 10-20 % (x =
15.5, n = 20); dorsaux, 10-17 % (x = 13, n = 20). Rapport entre longueur des vitel-
logènes et longueur du proglottis du côté poral: ventraux, 35-45 % (x = 40, n = 10);
dorsaux, 35-46 % (x = 41, n = 10); du côté aporal: ventraux, 40-65 % (x = 45, n = 10);
dorsaux, 39-63 % (x = 49, n = 10). Vitellogènes dorsaux plus distaux que les ventraux,
n'atteignant pas en général l'ovaire. Follicules vitellins ventraux chevauchant
l'extrémité de l'ovaire. Peu de vitellogènes dorsalement et ventralement à la poche du
cirre (Fig. 30).

Poche du cirre allongée, à paroi mince, longue de 230-450 (x = 360, n = 11), PC
= 20-30 % (x = 26, n = 25). Cirre très allongé, très mince et occupant entre 60-70 %
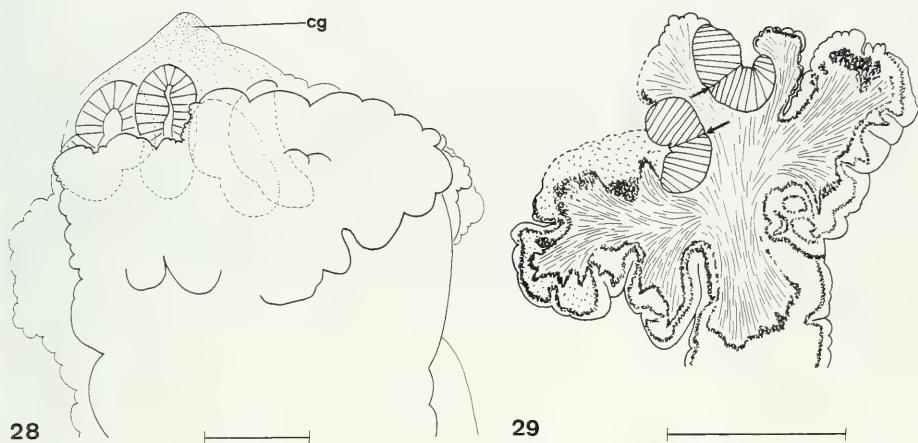
FIGS 28-29

Amphoteromorphus ninoi sp. n. 28. 22202 INVE, scolex avec une importante concentration de cellules à cytoplasme granuleux à l'apex. 29. Paratype 32859 INVE, coupe sagittale d'un scolex. Remarquer l'importante musculature longitudinale interne. *Echelles*: 28 = 300 mm; 29 = 500 mm.

de la longueur de la poche de cirre (Fig. 30). Pores génitaux unilatéraux. Vagin toujours antérieur à la poche du cirre (n = 70), pourvu d'un sphincter musculaire discret (Fig. 30). Canal éjaculateur relativement peu contourné. Canal déférent très contourné et dépassant le milieu du proglottis (Fig. 30).

Ovaire compact, parfois légèrement bilobé, à contour irrégulier, large de 360-775 (x = 440, n = 33) et occupant les 30-40 % (x = 35, n = 31) de la largeur du proglottis (Fig. 30).

Utérus pourvu d'un seul diverticule utérin de chaque côté (Fig. 30).

Oncosphères de 14-16 de diamètre (x = 15, n = 9), pourvues de crochets longs de 6-8 (x = 7.5, n = 9); embryophore des oeufs mûrs de forme ronde à ovoïde, divisée en deux couches. Diamètre de la couche externe de 28-35 (x = 31, n = 9). Enveloppe externe hyaline, peu épaisse, peu plissée et asymétrique, longue de 49-55 (x = 50, n = 9) (Fig. 31).

ANALYSE GÉNÉTIQUE (Tableau 2 et Fig. 37)

Huit systèmes enzymatiques sont utilisables, certains difficiles à interpréter. Les six échantillons analysés présentent un seul phénotype enzymatique aux loci AAT, AK, MDH et PGI et deux aux loci ALD et HK. Dans les deux derniers cas, l'un est présent chez les individus parasitant *B. filamentosum* et l'autre chez ceux qui parasitent *B. vaillanti*. *A. ninoi* présente trois phénotypes enzymatiques au locus ACP ; les trois sont présents chez les parasites de *B. filamentosum*, un seul au contraire est exprimé chez les parasites provenant de *B. vaillanti*. Au locus PGM, trois phénotypes enzymatiques existent également, les parasites de *B. filamentosum* en affichent deux, ceux de *B. vaillanti* un seul. Tous les échantillons de *A. ninoi* sont distincts des autres exemplaires analysés au loci AAT, MDH et PGI.
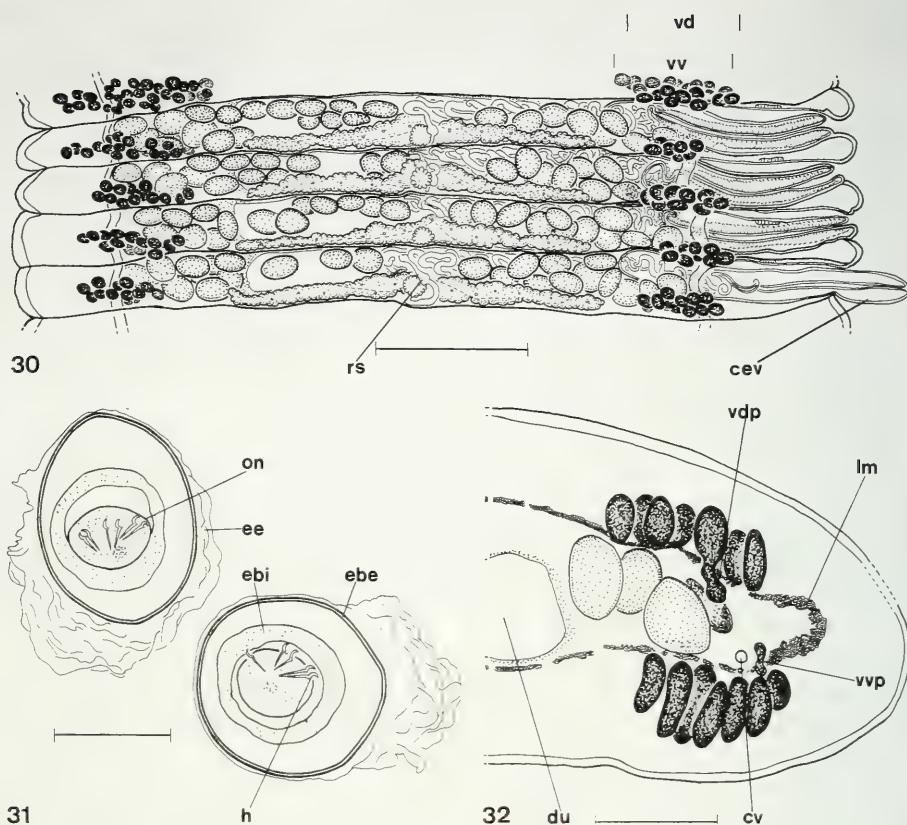
Figs 30-32

Amphoteromorphus ninoi sp. n. 30. Holotype 22203 INVE, vue dorsale de proglottis prégra-
vides, montrant la disposition décalée des vitellogènes ventraux par rapport aux dorsaux; canal
déférent très contourné et dépassant le milieu du proglottis; glande de Mehlis et réceptacle sémi-
nal bien visible; cirre évaginé. 31. 22202 INVE, oeufs montés dans l'eau distillée. 32. Paratype
32928 INVE, coupe transversale partielle d'un proglottis mature montrant la disposition des
vitellogènes corticaux et paramusculaires. Tégument peu plissé. *Echelles*: 30 = 500 mm; 31 = 25
mm; 32 = 100 mm.

En conclusion, l'analyse électrophorétique confirme la séparation spécifique de
A. ninoi. Les résultats aux loci ACP, ALD et PGM montrent des indices d'une
éventuelle séparation plus fine des parasites provenant de *B. vaillanti* et de *B. filamen-
tosum*. Vu le faible nombre de spécimens analysés et en l'absence de critères
morphologiques corrélés, nous ne pouvons pas en tirer des conclusions d'ordre
taxonomique.

Remarques

Amphoteromorphus ninoi est nettement différent des autres espèces du genre
(Tableau 1). Les testicules sont moins nombreux (Tableau 1). On remarque un décalage
constant dans la disposition de ses bandes vitellines ventrales par rapport aux dorsales.
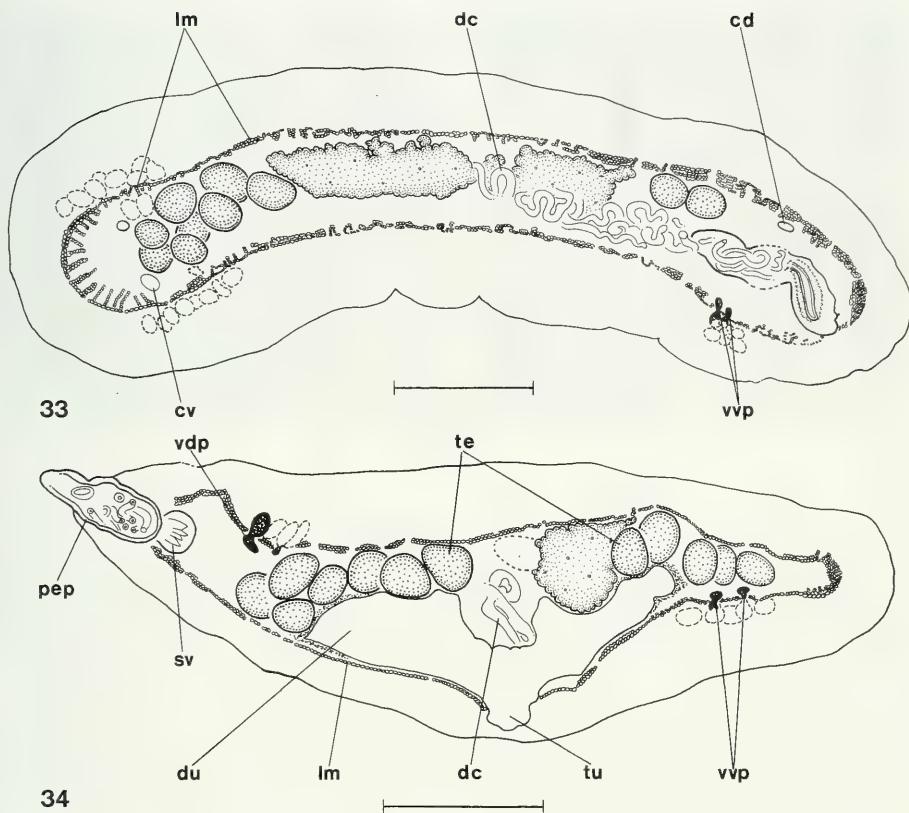
Figs 33-34

Amphoteromorphus ninoi sp. n. 33. 32860 INVE, coupe transversale au niveau du canal déférent d'un proglottis mature, montrant la musculature longitudinale interne (les faisceaux sont davantage concentrés aux marges du proglottis). 34. 22202 INVE, coupe transversale d'un proglottis mature. Noter les vitellogènes paramusculaires. *Echelles*: 33, 34 = 200 mm.

Le rapport entre largeur de l'ovaire et largeur des proglottis est plus faible que chez les autres espèces. Il n'existe qu'un diverticule utérin de chaque côté. Comparativement aux autres espèces, les proglottis sont proportionnellement plus larges et moins longs. D'autres caractères discrets concernent le tégument presque lisse et les nombreux follicules vitellins paramusculaires. En conclusion, nous considérons cette espèce comme nouvelle et l'appelons *A. ninoi*; elle est dédiée à Monsieur Aniello Carfora ("Nino"), père du premier auteur.
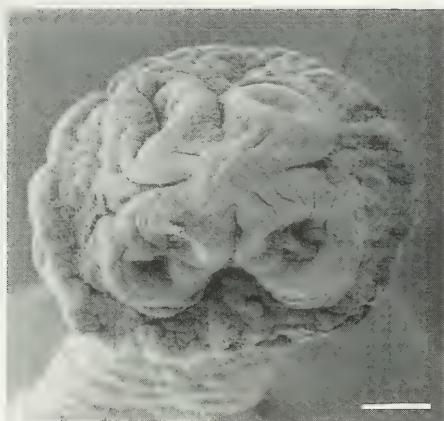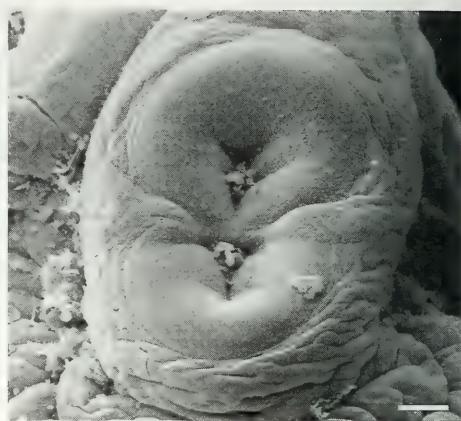
35   **36**

Figs 35-36

Amphoteromorphus piriformis sp. n. Photographies au microscope électronique à balayage (MEB). 35. 19310 INVE, scolex. Noter le métascolex plissé. 36. Agrandissement d'une ventouse bilobée. *Echelles:* 35 = 200 mm; 36 = 50 mm.

DISCUSSION GÉNÉRALE

Le genre *Amphoteromorphus* se compose donc de six espèces, toutes parasites de poissons-chats néotropicaux:

> *Amphoteromorphus peniculus* Diesing, 1850, hôte-type: *Brachyplatystoma flavicans,*
> *A. piraeeba* Woodland, 1934, hôte-type: *B. filamentosum,*
> *A. parkamoo* Woodland, 1935, hôte-type: *Paulicea luetkeni,*
> *A. piriformis* sp. n., hôte-type: *B. flavicans,*
> *A. ovalis* sp. n., hôte-type: *Brachyplatystoma* sp. et
> *A. ninoi* sp. n., hôte-type: *B. vaillanti,* autre hôte: *B. filamentosum.*

Cinq espèces du genre *Amphoteromorphus* présentent une spécificité oioxène, alors que *A. ninoi* parasite deux espèces hôtes (spécificité sténoxène). Deux espèces d'hôtes hébergent chacune deux espèces de parasites: *B. filamentosum* est parasité par *A. piraeeba* et par *A. ninoi*, *B. flavicans* par *A. peniculus* et par *A. piriformis.*

Les six espèces présentent un fort degré de ressemblance morphologique. A part *A. peniculus*, qui peut être séparé par l'alternance des pores génitaux, les cinq autres espèces se différencient par des caractères plus discrets. L'analyse de huit izoenzymes interprétables n'a pas apporté une réponse décisive dans tous les cas. *A. parkamoo, A. piraeeba* et *A. piriformis* présentent des mobilités électrophorétiques semblables pour les systèmes étudiés (Tableau 2 et Fig. 37). Même si le nombre d'échantillons examinés par électrophorèse est peu élevé, cette approche biosystématique s'est révélé
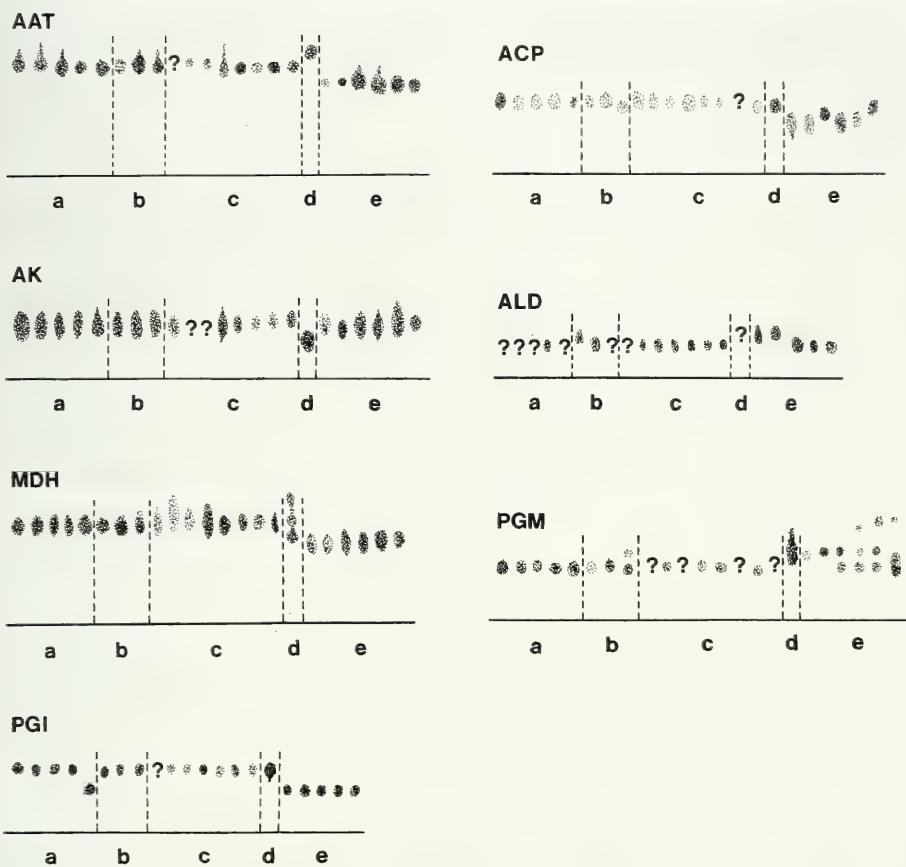
FIG. 37

Zymogrammes de sept systèmes enzymatiques des cinq espèces du genre *Amphoteromorphus*. a = *A. parkamoo*; b = *A. piraeeba*; c = *A. piriformis*; d = *A. ovalis*; e = *A. ninoi* (hôtes = *B. vaillanti*: 2 premières pistes, *B. filamentosum*.

précieuse en association avec les critères utilisés en taxonomie traditionnelle. Néanmoins, les trois espèces peuvent être séparées par plusieurs caractères morpho-anatomiques, métriques et méristiques (Tableau 1) d'importance taxonomique sûre (nombre de testicules, taille du scolex, forme de l'embryophore). Au contraire, *A. ovalis* et *A. ninoi* sont séparables, en plus de leurs profils électrophorétiques, par le nombre de testicules, la largeur comparative de l'ovaire, le nombre de diverticules utérins.

Chez toutes les espèces du genre, la longueur comparative de la poche du cirre, la longueur des crochets des oncosphères et la largeur des proglottis est très semblable. En dépit de leur ressemblance morphologique générale, certaines espèces présentent des apomorphies utiles pour l'identification. *A. ninoi* se distingue par ses vitellogènes peu nombreux, en bandes transversales, par la faible longueur de ses proglottis et par

la présence de deux diverticules utérins seulement. *A. piriformis* est le seul à posséder des embryophores mûrs piriformes. *A. piraeeba* possède un scolex en moyenne de fort diamètre.

CLÉ DE DÉTERMINATION

1   Pores génitaux irrégulièrement alternes; hôte: *Brachyplatystoma flavicans* . . . . *A. peniculus* Diesing, 1850

\-   Pores génitaux unilatéraux (ou avec une ou deux alternances dans de très rares cas) 2

2   Moins de 50 testicules par proglottis 3

\-   Plus de 50 testicules par proglottis 4

3   Moins de 33 testicules par proglottis; hôtes: *Brachyplatystoma filamentosum* et *B. vaillanti* . . . . *A. ninoi* sp. n.

\-   Entre 34 et 48 testicules par proglottis; hôte: *Paulicea luetkeni* . . . . *A. parkamoo* Woodland, 1935

4   Embryophore des oeufs mûrs de forme piriforme; hôte: *B. flavicans* . . . . *A. piriformis* sp. n.

\-   Embryophore des oeufs mûrs de forme ronde à ovoïde 5

5   Embryophore des oeufs mûrs de forme ovoïde. Scolex 980-2310 de diamètre; hôte: *Brachyplatystoma* sp. *A. ovalis* sp. n.

\-   Embryophore des oeufs mûrs de forme ronde. Scolex 2000-3740 de diamètre; hôte: *B. filamentosum* . . . . *A. piraeeba* Woodland, 1934

REMERCIEMENTS

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The presence of Soprano pipistrelle *Pipistrellus pygmaeus* (Leach, 1825) in Switzerland: first molecular and bioacustic evidences

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The presence of Soprano pipistrelle *Pipistrellus pygmaeus* (Leach, 1825) in Switzerland: first molecular and bioacustic evidences. - The two widespread sibling species of pipistrelle bats, the soprano pipistrelle (*Pipistrellus pygmaeus*), and the common pipistrelle (*Pipistrellus pipistrellus*), that emit at distinct call frequencies (maximum energy at around 55 and 45 kHz respectively), have been found in sympatry over much of Europe, but little is known about their relative abundance and possible habitat use. In this study, we provide the first record of *P. pygmaeus* in southern Switzerland, confirmed by echolocation analysis and mitochondrial DNA sequencing. During 70 catching sessions in the southern region of the Swiss Alps, echolocating bat calls were recorded to define the distribution/presence of the two species. Habitat characteristics of capture sites suggested that the sibling species have a high degree of niche overlap (0.88). Nevertheless, *P. pygmaeus* seemed to select agricultural areas and riversides more frequently than *P. pipistrellus,* which is found more often in urban areas. Divergence in the cytochrome b gene of mitochondrial DNA of 37 bats confirmed the echolocation data for 31 of 33 *P. pipistrellus* and for two of four *P. pygmaeus,* while four animals, two of each species, had been misclassified based on echolocation only. A canonical discriminant function using morphological data was not reliable to distinguish the sibling species.

Key-words: Chiroptera - *Pipistrellus pygmaeus* - Sibling species - mtDNA - echolocation - Switzerland.

INTRODUCTION

The study of sibling species has great importance in community ecology, zoogeography and conservation. Sibling species exist in many zoological *taxa* (insects and Vertebrates as fishes, reptiles and rodents). Among European bats, this has been

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demonstrated for *Myotis myotis* and *Myotis blythii* (Arlettaz *et al.*, 1993, 1997; Arlettaz, 1996) and for *P. pipistrellus* and *P. pygmaeus* (Barlow, 1997; Barlow & Jones, 1997, 1999). Populations of sibling bat species living in sympatry are defined as cryptic species, because they consist of individuals that are morphologically similar, or even identical, that can only be recognised by biomolecular or bioacoustical methods.

The case of the common pipistrelle bat (*Pipistrellus pipistrellus* Schreber, 1774) is probably one of the most surprising and interesting discoveries among European mammals: until 1999, this species was regarded as a single biological unit. In 1993 two different phonic types were discovered among British pipistrelles: individuals emitting two distinct search-phase echolocation calls were recognized, with frequencies of maximum energy at around 45 kHz and at around 55 kHz (Jones & Van Parijs, 1993). Subsequently, genetic analysis proved that the Europe's most widespread and well-studied bat actually exist as two cryptic species (Barratt *et al.*, 1997), separated by a sequence divergence of >11% in the cytochrome b gene of mitochondrial DNA. Despite the fact that a definitive taxonomic classification is not yet defined (von Helversen *et al.*, 2000; Mayer & von Helversen, 2001) we have chosen to adopt the name proposed by Jones & Barratt (1999), based on suggestions made by Hutson and Jones (von Helversen *et al.*, 2000: pp.115, 116). Jones and Barratt (1999) proposed the nomenclature *Pipistrellus pygmaeus* (Leach, 1825) for the phonic type "55 kHz" - popularly called soprano pipistrelle, thanks to its high-pitched call - while the phonic type "45 kHz" remains the common pipistrelle, *Pipistrellus pipistrellus*. The two phonic types can be readily identified by using a bat detector, and have been found in sympatry in Switzerland (Zingg, 1990; Letard & Tupinier, 1997), Great Britain (Jones & Van Parijs, 1993), North of Ireland (Russ, 1996), central Spain (Ruedi *et al.*, 1998; Mayer & von Helversen, 2001), Germany (Häussler *et al.*, 1999; Mayer & von Helversen, 2001), France (Lustrat, 1999) and in the South of Italy and Sardegna (Russo & Jones, 2000). In other countries the presence of the *P. pygmaeus* is recorded also for Greece (Weid & von Helversen, 1987; Mayer & von Helversen, 2001), Denmark, Norway and Portugal (Jones, 1997).

In the northern part of the Swiss Alps, a first bioacoustical record of two forms of echolocating common pipistrelles was made by Zingg already in 1990 even though Zingg didn't identify them as two different species but as two different phenotypes. The presence of two species, after the classification of Jones & Barratt (1999), has never been confirmed in Switzerland by biomolecular evidence. In this study, we investigate the occurrence of the two sibling species of *Pipistrellus* in the Southern region of the Swiss Alps, that includes the Cantone Ticino (Switzerland) and two northern provinces of Italy (Como and Varese), using biomolecular and bioacoustical analyses, and analysing environmental and morphological data.

MATERIALS AND METHODS

STUDY AREA AND CAPTURE METHODS

The study was carried out from May to October 2001. We visited 70 sites (Fig. 1), 52 in Cantone Ticino (Switzerland), 10 in the province of Como (Italy) and 8 in the province of Varese (Italy), where we captured different bat species. The study

Fig. 1
Study area. Dots indicate sampling sites.

area extends over 7152 km² (coordinates range: 46°33'46.8"N; 9°15'43.2"E; 45°35'16.8"S; 8°22'33.6"W) and the landscape consists of 20% lowlands, 45% hills and 35% mountains, with elevation ranging from 200 m a.s.l., at Lake Maggiore, Varese province, to over 3000 m in the Swiss Alps (Rheinwaldhorn, 3348 m), in the northern part of the study area. The continental climate is tempered by the large lakes, with relatively mild winters, and abundant precipitation ranging from 1500 to 2200 mm per year.

Most sites visited in the study area (n = 45) were maternity roosts located in houses that had been previously signalled by local people to the Centre for the Protection of Bats of the Canton Ticino, a local bat conservation group founded in 1990. A church, two factories and one cave were also checked for bats. Additionally, 19 foraging sites along rivers and water-courses (random points) and 115 bat boxes in two deciduous woodlands were monitored.

Bats were captured during evening emergence at roosts, using hand-nets, which allowed us to catch only part of the individuals in each of the colonies. Of all caught bats, morphological measurements were taken and their echolocation calls were recorded, while skin samples were taken from a maximum of five animals per site. The total number of animals emerging was counted.

At foraging sites, mist-nets were placed along ponds and water-courses, as described by Kunz (1988), that remained activated from dusk to midnight, and all the data described above were taken for each captured bat. Bats roosting in boxes, mainly males in mating groups, were taken by hand.

SAMPLING PROCEDURE

Each captured bat was sexed and aged. The age-class, (sub-adult or adult), was determined based on epyphyseal growth plates closure in the metacarpal-phalangeal joint of the fifth finger (Anthony, 1988). Reproductive condition was assessed checking testes development in males and lactation in females (Racey, 1988). Females were defined lactating when milk appeared while gently squeezing the nipples, or when the fur surrounding nipples was absent. Twelve morphological measurements of bats were taken using a precision callipers ($\pm$ 0.01 mm): forearm length, wing span (from the wing extremity to the shoulder, gently stretching out the left wing,), III and V finger (from thumb insertion to III finger extremity and V finger extremity respectively, gently stretching out the left wing), II and III phalanx of III finger, thumb (from thumb insertion to thumb extremity without nail), foot (from heel to the third finger extremity without nail), tibia, tail (from anus to tail extremity), and ear length (from tragus insertion to ear extremity). Bats were weighed to the nearest 0.5 g with a 50 g Pesola dynamometer. In a first step, bats were determined as belonging to one of the sibling species using their echolocation characteristics, morphological measurements were compared by multivariate analysis of variance (MANOVA, Sokal & Rohlf, 1995). In a second step, the morphological parameters that were significantly different between the two species were analyzed with the SYSTAT statistical package (SPSS, 1997) in order to calculate a Discriminant Function with Jackknife procedure (Hinkley, 1977) to determine the percentage of cases classified correctly (significance was tested with a F-transformed Wilk's lambda test, Tukey, 1977). Finally, a canonical discriminant function was calculated to distinguish between the two species.

For each bat, echolocation calls were recorded in time expansion mode with a Pettersson D980 bat detector, while releasing it from the hand in open habitat near the roost. Echolocation calls spectrograms were subsequently obtained (1024 points Fast Fourier Transform, Parzen window) and analysed using BatSound software (Pettersson, 1999). For statistical analysis, to avoid sample size problems, a subset of 18 randomly chosen recordings of *P. pipistrellus* were compared with the total data set

of 18 *P. pygmaeus*. For each recording, six characteristic frequency-domain parameters were measured: start frequency (F_{start}), maximum frequency (F_{max}), minimum frequency (F_{min}), frequency at maximum intensity (F_{maxint}), end frequency (F_{end}), and frequency at half the duration of the search phase call ($F_{t/2}$). Finally, call duration (in ms) was also measured. Each parameter was compared between the two sibling species with a non-parametric Mann-Whitney U-test. Significant parameters were then used in a Discriminant Function Analysis with Jackknife procedure, to obtain a classification function based on these echolocation parameters.

GENETIC ANALYSIS

Two tissue samples of 4 mm diameter were taken from the tail membrane (uropatagium) of each skin-sampled bat using a biopsy punch, and placed in a 0.2 ml eppendorf vial filled with 70% ethanol and stored at −20 °C until the moment of genetic sequencing. Genetic analyses were carried out on a total of 137 bats, for which also bioacoustic and morphologic data were available. All bats were handled with care and kept as little as possible to avoid stress, and no animals were injured or died during handling.

DNA from tissue samples was extracted using the QIAmp DNA Mini kit (Qiagen) following supplier's instructions. Each sample was amplified by PCR (Saiki *et al.*, 1988) using primers L14841 and H15149 (Kocher *et al.*, 1989), targeting a 307 base pairs (bp) portion of the mitochondrial DNA (mtDNA) cytochrome *b* (cyt *b*) gene. Double-stranded cycle sequencing was conducted using the ABI PRISM™ BigDye Terminator Cycle Sequencing Ready Reaction kit, Version 3.0 (Applied Biosystems). Purified sequencing products were loaded on a ABI PRISM™ 377 DNA sequencer (Applied Biosystems). Both strands have been sequenced with the same primers used in the PCR amplification. For species identification, the DNA sequences obtained from the samples were compared with homologous sequences of other Chiroptera available in DNA databases, in particular with the *Pipistrellus spp.* sequences from Barratt *et al.* (1997) (GenBank accession nr. U95499, U95501, U95503, U95505, U95507, U95509). Distance matrix calculation (Kimura 2-parameter distances; Kimura, 1980) and phylogenetic analysis (maximum parsimony, exhaustive search with *Rhinolophus ferrumequinum* (U95513) as outgroup) were performed with PAUP* 4.0b8 (Swofford, 2001). Resolution of internal nodes was evaluated using 10000 bootstrap replications with the PAUP* package.

HABITAT ANALYSIS

A Geographical Information System was set up with ESRI ArcView GIS version 3.2 (ESRI, 1999), using scanned 1:25000 paper maps from the Swiss Federal Office of Topography and Regione Lombardia CT10 1:10000 Technical Regional Digital Cartography as reference coverages. Land cover data was derived from the GEOSTAT data sets (Swiss Federal Statistical Office, 1997) for the Swiss portion of study area, and from CORINE Land Cover coverage (Commission of the European Communities, 1993) for the Italian part. Sampling sites were digitized heads-up using the above cited reference maps. Due to the different projection systems used in Switzerland and Italy, all the Italian geographic datasets were converted using ESRI

ArcGIS ARC/INFO 8.1 PROJECT routine (Booth, 1999) into Hotine Oblique projec-
tion (Swiss Reference Grid) and harmonised with GEOSTAT geodataset. Furthermore,
CORINE Land Cover coverage has been converted to raster format and downsampled
at the same spatial resolution of GEOSTAT, that is at a pixel size of 0.1 km². Because
of different classification criteria in the two land cover datasets, classes were pooled
and standardized according to Land Cover Classification System standards (Di
Gregorio & Jansen, 2000), yielding the land cover classes shown in Table 1.

TABLE 1. The percentage of habitat use by the sibling species *Pipistrellus pipistrellus* (N = 3984
locations) and *P. pygmaeus* (N = 404 locations), and the percentage of available habitat deter-
mined for the entire study area based on 0.1 km² grid cells.

| Habitat types | Habitat use | | Available |
	P. pipistrellus	*P. pygmaeus*	habitat
Woodland	46.4	46.0	44.5
Shrubland	0.4	0.5	3.9
Orchards, vineyards	6.3	7.2	5.3
Cultivated farmland	0.8	5.7	4.5
Meadows, alpine meadows	10.8	6.7	16.0
Water	4.2	9.9	5.8
Sterile land	0.6	0.5	7.7
Urbanised land	30.4	23.5	12.4

Finally, in order to obtain habitat class frequency for all the sampling sites, each
point site was buffered using a fixed radius of 500 m, and converted into raster, and
habitat class frequency was recorded as number of 0.1 km² pixels intersecting or con-
tained in the buffered areas.

Habitat use and habitat overlap were both evaluated using a normalized version
of the Proportional Similarity Index (PS_n), that is

$$PS_n = \frac{PS - \min(q_i)}{1 - \min(q_i)} \; ; [0 \le PS_n \le 1],$$

where PS is the Czekanowski's Proportional Similarity Index (Feinsinger *et al.*, 1981):

$$PS = 1 - \frac{1}{2}\sum_i |p_i - q_i| = \sum_i \min(p_i, q_i).$$

The symbols p_i and q_i indicate respectively the proportion of used and available land
use class, when PS_n is used to estimate niche breadth, whereas the same notations
indicate the proportion of habitat used by each species when PS_n is used to estimate
niche overlap; $\min(q_i)$ represents the minimum observed resource item frequency.

Habitat preference by each species was evaluated using Ivlev's Electivity Index
(Jacobs, 1974).

RESULTS

A total of 371 bats of different species were captured and analysed, 240 of
which belonged to one of the two *Pipistrellus* sibling species. In a first step, distinction
between *P. pipistrellus* and *P. pygmaeus* was based on acoustical data analysis. For a

subset of 18 individuals of each species, there was no difference in call duration (Mann-Whitney U-test: U = 105.5, p = 0.07), and in call maximum frequency (Fig. 2b, U = 121.0, p = 0.20). All other call parameters differed significantly between the two sibling species (Fig. 2, Mann-Whitney U-test all p < 0.01) and the largest difference was found for the frequency at maximum amplitude, on average 46.48 kHz for *P. pipistrellus* and 57.52 kHz for *P. pygmaeus* (Fig. 2e, U = 0, p < 0.01). Using only significant call frequency variables, a canonical discriminant function analysis (DFA) was calculated ($F_{approx.}$ = 35.0; df =5, 30; p < 0.001), which permitted us to determine 181 of the 201 recorded individuals' as *P. pipistrellus* and 20 as *P. pygmaeus*. The discriminant function, in its canonical form is

$$y = 21.101 + 0.033F_{start} - 0.071F_{min} - 0.407F_{maxint} - 0.081F_{end} + 0.102F_{1/2}$$

with a total discriminant capacity of 94%. Negative y values refer to *P. pygmaeus*, while positive ones refer to *P. pipistrellus* (Fig. 3).

Reconstruction of the phylogenetic tree by maximum parsimony and 10000 bootstrap replications showed that 33 of the 37 samples of *Pipistrellus*, belonged to the species *P. pipistrellus,* and four to *P. pygmaeus*. Of the four bats classified erroneously based on echolocation data, two genetically determined *P. pygmaeus* had been first determined as *P. pipistrellus* based on frequencies at maximum call intensity (F_{maxint}) of 45.40 and 45.94 kHz respectively, while two genetically determined *P. pipistrellus* had been first classified as *P. pygmaeus* based on (F_{maxint}) of 57.05 and 61.90 kHz.

Analysis of the 307 base pairs of the mtDNA cyt *b* gene confirmed DFA results, except for four animals that had been misclassified. The comparison of DNA sequences obtained with DNA reference sequences resulted in a K2P genetic distance of 0.4% between the two *P. pipistrellus,* 0.4% between the two *P. pygmaeus*, and 12.8 ± 0.5% between the two species. The MANOVA on the 12 morphological traits was statistically significant (F = 4.40; df = 12, 171; p < 0.001) and seven out of 12 morphological parameters differed significantly between the two sibling species at the 1% level (one-way ANOVA, level of significance p < 0.01, Table 2). A discriminant function for each species was calculated using only the four parameters that had the highest significance level (single one-way ANOVA, p < 0.001, Table 2). For *P. pipistrellus*, the slightly larger species, the discriminant function was described by

$$y = -499.91 + 20.58thumb + 3.93tibia + 2.24tail + 25.35 \, forearm$$

while for *P. pygmaeus* it was

$$y = -463.34 + 18.66thumb + 3.02tibia + 1.84tail + 25.15 \, forearm$$

The Jackknife procedure classified correctly 141 out of 175 (81%) *P. pipistrellus*, and 16 out of 20 (80%) *P. pygmaeus* (probability of uncorrect assessment: Wilk's lambda $F_{approx.}$ = 9.99; df = 4, 190; p < 0.0001). The canonical discriminant function obtained was described by

$$y = -24.92 + 1.28thumb + 0.61tibia + 0.26tail + 0.13 \, forearm$$

with y < 0 indicating *P. pipistrellus* and y > 0 indicating *P. pygmaeus* (Fig. 5). Thus, taking into account that about 19% of animals were misclassified, morphological measurements alone are not sufficient to distinguish between the two pipistrelle sibling
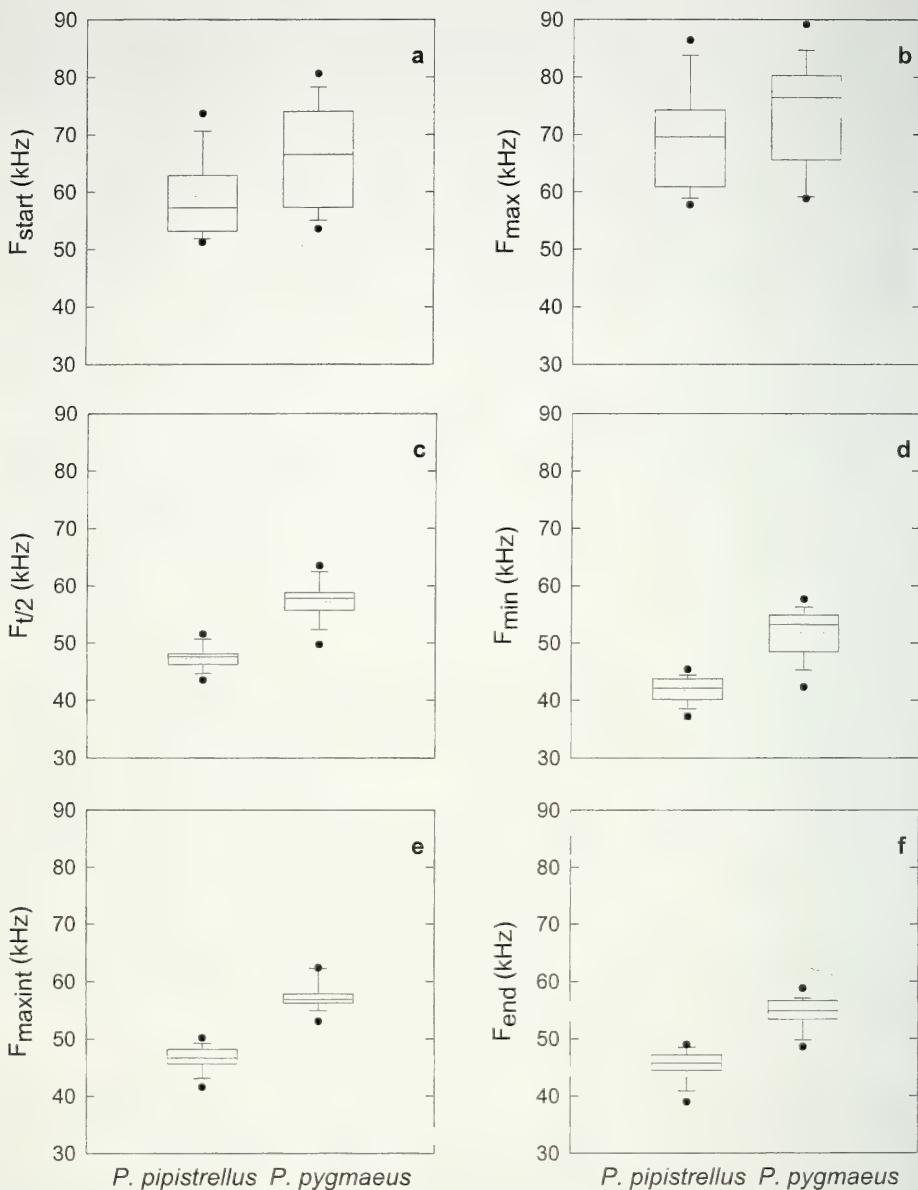
FIG. 2

Box-and-whisker plot comparison between *Pipistrellus pipistrellus* and *P. pygmaeus* ultrasonic search-phase call parameters: a: F_{start}, b: F_{max}, c: $F_{t/2}$, d: F_{min}, e: F_{maxint}, f: F_{end}.

species in our study area. Finally, following Häussler *et al.* (1999) we also calculated the mean differences between the second and third phalange of the 3rd finger, but found no significant difference between the sibling species (Mean difference ± sd in mm: *P. pipistrellus* 1.05 ± 0.70; *P. pygmaeus* 1.10 ± 0.91; t-test t = 0.27; df = 187; p = 0.79).
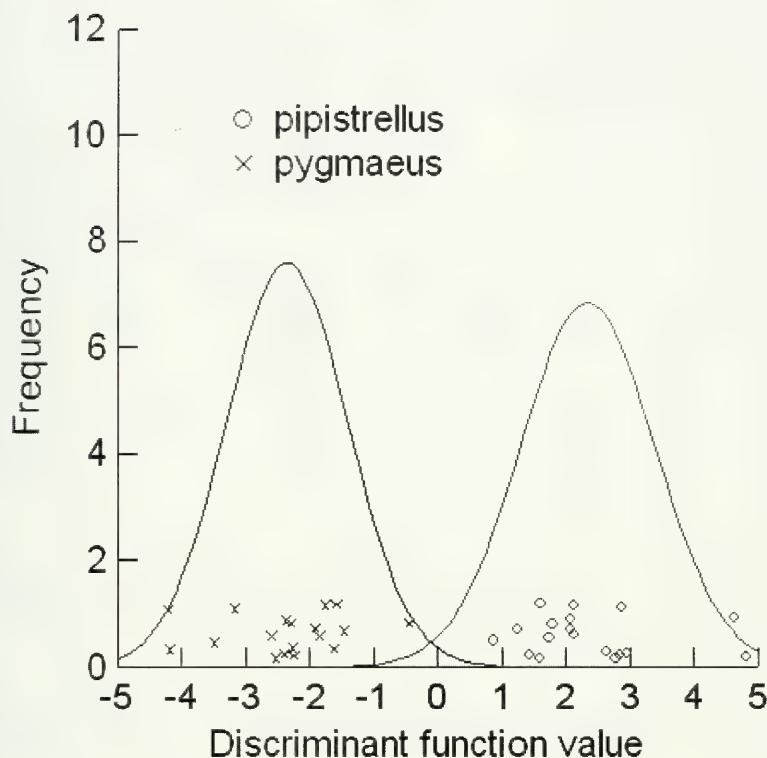
FIG. 3

Discriminant Function Analysis (DFA) canonical scores plot for ultrasonic search-phase call parameters in *Pipistrellus* spp.

Of the 33 *P. pipistrellus* examined, 23 (70%) had been captured at 10 different roosts in houses, eight (24%) along foraging sites in the Cantone Ticino, Switzerland, and two (6%) at one foraging site in the province of Como, Italy. Two *P. pygmaeus* had been captured at Gordevio, along the river Maggia, and two in bat boxes at Bosco Isolino, Cantone Ticino, Switzerland (Fig. 1).

Using both echolocation and genetic determination of the two sibling species, we compared the habitat characteristics of the sites where they had been found (N = 3984 for *P. pipistrellus*, N = 404 for *P. pygmaeus*, Table 1). Spatial niche breadth values were high and similar for both species (PS_n = 0.78 for *P. pipistrellus*; PS_n = 0.79 for *P. pygmaeus*), and there was a high degree of niche overlap (PS_n = 0.88). Each species used habitat types in a significantly different fashion if compared with habitat availability (Table 1; χ^2 = 41.4; df = 7; p < 0.001 for *P. pipistrellus*; = χ^2 = 29.2; df = 7; p < 0.001 for *P. pygmaeus*). The Ivlev's electivity index showed avoidance for sterile land (non-vegetated areas, bare rock and glaciers), shrubland and meadows, and positive selection for orchards and urbanised areas in both species. Farmland and water bodies were avoided by *P. pipistrellus*, but positively selected by *P. pygmaeus* (Fig. 4).
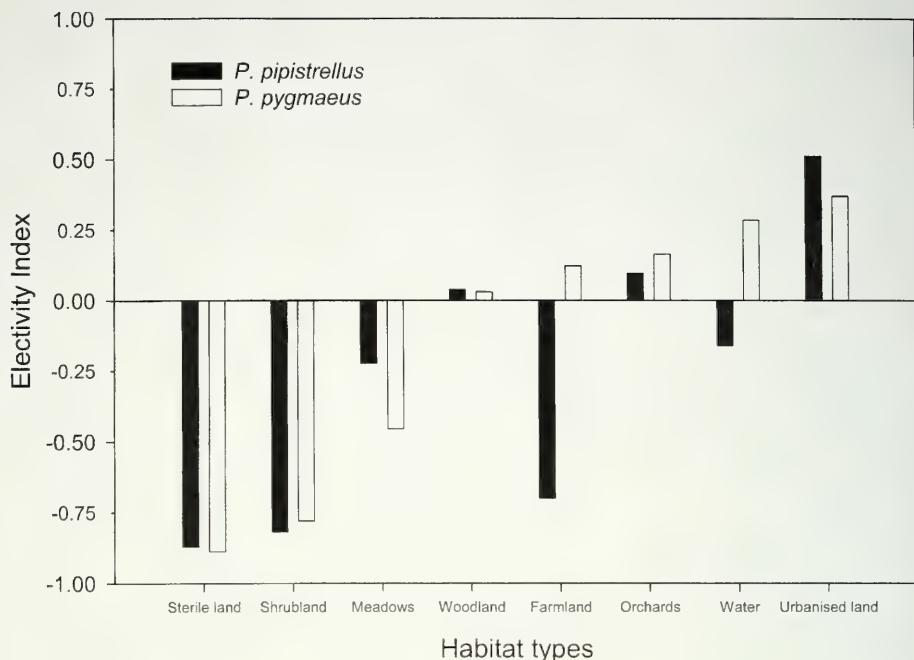
FIG. 4
Ivlev's Electivity Index values by habitat type for *Pipistrellus pipistrellus* and *P. pygmaeus*.

DISCUSSION

Morphological data from the two sibling species from the Rhine valley in Southwest Germany suggested that *P. pipistrellus* tends to be slightly larger than *P. pygmaeus* (Häussler *et al.*, 1999). In particular, there was a significant difference in mean length of the forearm, fifth finger and average tail length. This was confirmed by our data of external morphological measurements taken on live animals from alpine and prealpine areas of southern Switzerland and the provinces of Varese and Como, northern Italy. However, although differences in mean size existed, individual variation was large and there was considerable overlap in all measurements that were taken. Consequently, the best canonical discriminant function still misclassified about 20% of bats of each sibling species in our study area. Häussler *et al.* (1999) suggested that the difference in length between the 2nd osseous phalange and the terminal 3rd cartilaginous phalange of the 3rd finger, almost the same length in *P. pygmaeus*, while in *P. pipistrellus* the 3rd phalange is generally 2-3 mm shorter than the 2nd, is a useful diagnostic morphological characteristic that can be measured in the field. However, they do not produce any statistical evidence for this statement. Moreover, in our study area there was no such difference, indicating that it can not be used as a reliable diagnostic criteria. Thus, morphological measurements alone are not sufficient to investigate the presence/absence or distribution of the pipistrelle sibling species, at least in the southern Swiss Alps and confining areas in northern Italy.
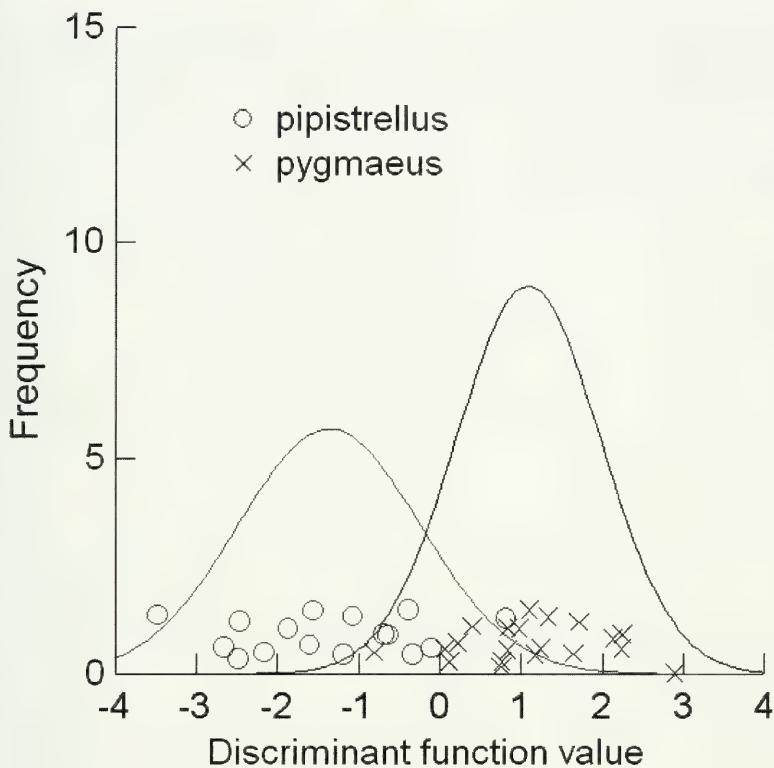
FIG. 5
Discriminant Function Analysis (DFA) canonical scores plot for biometric parameters in
Pipistrellus spp.

In contrast, a detailed analysis of echolocation calls allowed us to calculate a
canonical discriminant function which resulted in correct determination of 35 out of 36
bats (97%). In agreement with previous studies in different parts of Europe (Weid &
von Helversen, 1987; Jones & Van Parijs, 1993; Vaughan *et al.*, 1996, 1997; Barlow,
1997; Barlow & Jones, 1999; Russo & Jones, 2000; Mayer & von Helversen, 2001),
the frequency at maximum intensity of the search phase call was the call parameter
with the lowest inter-specific overlap (see Fig. 2). However, we must underline that
definitive species determination using the 307 bp sequence of the cyt-b gene of
mtDNA, demonstrated that in some cases, species classification based on echolocation
calls had failed. In part this might be caused by the individual variation in search phase
call frequency in both sibling species, found also in British colonies (Barlow & Jones,
1999), with some individuals using frequencies 5-7 kHz above or below the mean value
(see Fig. 2e). Other sources of erroneous classification can be linked with recording
conditions. Therefore, we want to stress that a low error rate when discriminating bat
species by means of their echolocation calls can only be ensured when the following
conditions are met: (1) high-quality equipment (bat detector and sonagraph or

computer-based Digital Signal Processing system); (2) ideal call recording conditions (no nearby obstacles, no interference by other bats with the recorded individual, limited distance between recorder and animal); (3) released bats in good condition, not stressed or suffering cold; (4) recording of the correct search phase call, not of other call types (e.g. social calls); (5) correct choice of call parameters for data analyses; and (6) appropriate statistical analysis.

Although other studies on sympatric pairs of cryptic bat species have shown there can be considerable habitat niche differentiation (Arlettaz, 1996; Arlettaz *et al.*, 1997), this was not the case for the sibling pipistrelle species in our study area which both had a large niche width, and a high degree, about 88%, of niche overlap. Nevertheless, some differences in habitat selection could be noted. As in south-west England, the foraging habitat of the soprano pipistrelle (*P. pygmaeus*) was more associated with water and riparian habitats, probably related to its diet consisting largely of insects with aquatic larval stages, while it clearly avoided urbanised areas (Barlow, 1997; Vaughan *et al.*, 1997). Also, in the landscape around maternity roosts, water courses and riparian habitat belts were present, as well as farmland, and no roosts were found in houses. This contrasted findings from Scotland, were *P. pygmaeus* selected house roosts that had a higher degree of nearby cover (large trees) than random houses (Jenkins *et al.*, 1998). However, these house roosts were surrounded by a greater area of deciduous and coniferous woodland than random buildings and nearly always within 500 m from a major river (Jenkins *et al.*, 1998), which underlines the importance of cover and the presence of nearby riparian habitats for this species (Oakeley & Jones, 1998). This was confirmed by our data with soprano pipistrelles roosting in nest boxes in deciduous woods, thus in a habitat with good cover, and foraging often along rivers and lakes. In contrast, most roosts of the common pipistrelle (*P. pipistrellus*) were in buildings. The latter species, commonly found in woodlands, also foraged intensively in cities and small villages as well as in nearby farmland. Although sometimes found at water or riparian foraging sites and roosts, it used these habitats less frequently than the soprano pipistrelle. Thus, habitat requirements are slightly different for the two sibling species (Vaughan *et al.*, 1997), with the common pipistrelle being a habitat generalist and the soprano pipistrelle selecting riparian habitats and farmland. However, overall, there were only small differences in our measurements of habitat use by the sibling species (see Table 1), resulting in a high degree of habitat niche overlap, and differentiation may be more accentuated for other niche components. In fact, both in our study and in others (Park *et al.*, 1996; Barlow, 1997; Oakeley & Jones, 1998; Jenkins *et al.*, 1998), there were no roosts occupied by both species simultaneously. Moreover, diet studies of the sibling pipistrelles in the British Isles showed that although both species ate mostly the dipteran suborder Nematocera and there was no difference between the phonic types in dietary breadth, there were some differences in food choice (Barlow, 1997). The main prey groups in the diet of *P. pipistrellus* were the families Psychodidae, Anisopidae and Muscidae, whereas the families Chironomidae and Ceratopogonidae occurred most frequently in the diet of *P. pygmaeus* (Barlow, 1997). Thus, stable co-existence of sympatric populations of *P. pipistrellus* and *P. pyg-maeus* in heterogeneous landscapes seems possible because of differential selection of roost sites and preferred prey. Further studies are needed to test this hypothesis and to

TABLE 2. Morphological characteristics (mean ± sd) of 164 *Pipistrellus pipistrellus* and 20 *P. pygmaeus*. Determination of sibling species based on echolocation call frequency. Differences between means for each single parameter tested by one-way ANOVA (df = 1, 182 in all cases).

Parameter	*P. pipistrellus*	*P. pygmaeus*	F	p
Body mass (g)	4.95 ± 0.59	5.13 ± 0.92	1.22	0.27
Tumb (mm)	4.34 ± 0.36	4.02 ± 0.35	15.8	< 0.001
Tibia (mm)	11.74 ± 0.50	11.22 ± 0.67	17.8	< 0.001
Foot (mm)	6.53 ± 0.62	6.46 ± 0.36	0.15	0.70
Tail (mm)	31.98 ± 2.11	29.54 ± 1.84	25.1	< 0.001
Ear length (mm)	9.50 ± 0.88	9.36 ± 0.72	0.24	0.62
Forearm (mm)	31.19 ± 1.01	30.28 ± 1.29	14.1	< 0.001
III Finger (mm)	54.34 ± 2.56	52.27 ± 3.06	11.5	0.001
V Finger (mm)	40.00 ± 1.96	38.84 ± 1.87	6.37	0.012
III Phalanx (mm)	7.22 ± 0.53	6.82 ± 0.71	8.48	0.004
II Phalanx (mm)	8.27 ± 0.60	7.92 ± 0.58	6.59	0.011
Wing length (mm)	93.54 ± 3.39	91.26 ± 4.97	7.72	0.006

investigate whether the realised niche width of allopatric populations of *P. pygmaeus* differs from that of conspecifics in sympatry with the sibling species.

Collecting further information on habitat composition of foraging sites and location of preferred roosting sites of *P. pygmaeus* will be essential for landscape management and planning of specific conservation measures. For example, modification of certain riparian habitats and water courses by constructing sewage plants and conductors could cause marked changes of the invertebrate fauna of rivers, torrents and small lakes downstream of the sewage output, and thus alter food availability for, and activity of, foraging bats (see also Vaughan *et al.*, 1996). Since the soprano pipistrelle feeds primarily on insects with aquatic larval stages, such modifications might have serious consequences for the local survival of soprano pipistrelle populations.

We conclude that our genetic data definitively confirm that both *P. pipistrellus* and *P. pygmaeus* occur in Switzerland. Furthermore, our results indicate that correct monitoring of echolocation calls of pipistrelle bats is the most appropriate technique for large-scale studies on presence/absence and distribution of the two sibling species, but larger samples of genetically identified *P. pygmaeus* are needed to verify how reliable echolocation analyses are for correct species determination, as well as careful ultrasound recording.

ACKNOWLEDGEMENTS

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Description of a new species of *Tityus* (Scorpiones, Buthidae) from Serra do Cipo in the State of Minas Gerais, Brazil

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Description of a new species of *Tityus* (Scorpiones, Buthidae) from Serra do Cipo in the State of Minas Gerais, Brazil. - *Tityus adrianoi* sp. n., belonging to the *Tityus bahiensis* species group (Scorpiones, Buthidae) is described on the basis of one female specimen collected in the region of the Serra do Cipo, State of Minas Gerais, Brazil. Comments on the taxonomic position of the new species and on the environmental characteristics of the type locality are given. An identification key of the species belonging to the *Tityus bahiensis* group distributed in the Cerrados is provided. Some comments on their patterns of geographical distribution are added.

Key-words: Scorpiones - Buthidae - *Tityus adrianoi* sp. n. - Serra do Cipo - Cerrados - Brazil.

INTRODUCTION

Tityus species which inhabit the Cerrados landscape formations of Central Brazil and belong to the *Tityus bahiensis* species group (as defined by Lourenço, 2002), have been the subject of several taxonomic studies in the last 20 years. Noteworthy among these species are: *Tityus fasciolatus* Pessôa and *Tityus charreyroni* Vellard (Lourenço, 1980); *Tityus stigmurus* (Thorell) and the related species *Tityus serrulatus* Lutz & Mello (Lourenço, 1981); *Tityus bahiensis* (Perty) and related species (Lourenço, 1982). In subsequent contributions, precise patterns of distribution and differentiation have been synthesised (Lourenço, 1986, 1994, 1996), and I assumed that the *Tityus* species living in the Cerrados were largely known. Several regions within the Cerrado formations of Central Brazil have been intensively surveyed, mainly in connection with scorpionism (Lourenço & Cloudsley-Thompson, 1996; Lourenço *et al.*, 1996). This is the case in particular for the states of Minas Gerais and Goiás.

The recent discovery and description of new *Tityus* species from the Cerrado formations of Central Brazil (Lourenço, 2001a,b) attests, however, that the inventory work is far from being complete. In the present paper a new species, *Tityus adrianoi* sp. n., belonging to the *Tityus bahiensis* species group, is described from a female specimen collected in the region of the Serra do Cipo, State of Minas Gerais. The Serra

do Cipo region is part of the Central Brazil Cerrado formations, and separates the Atlantic forest zone from the Cerrado region (Eiten, 1978, 1982). The taxonomic position of the new species, and the environmental characteristics of the type locality are discussed.

RESULTS

DESCRIPTION

Tityus adrianoi sp. n.   Figs 1-10

   Type. Brazil, State of Minas Gerais, Serra do Cipo region (Campo Rupestre formation), female holotype, 28/III/1963 (J. Lacroix leg.), deposited in the Natural History Museum, Geneva.

   Etymology. Patronym in honor of Dr Adriano Monteiro de Castro Pimenta of the Universidade Federal de Minas Gerais, Belo Horizonte, for his continuous interest in the study of scorpions.

   Diagnosis. Scorpion of medium size, with 55 mm of total length. Coloration reddish yellow to yellowish, with the carapace and tergites blackish brown. Granulation strong throughout the body. Fixed and movable fingers of pedipalps with 15/16 rows of granules. All carinae complete. Pectinal teeth count 21.

   Description. Coloration. Basically reddish yellow. Prosoma: carapace blackish brown in the anterior and lateral regions; the anterior region with an inverted triangular blackish spot stretching from the median eyes to the lateral eyes; regions behind the ocular tubercle and lateral eyes yellowish; eyes strongly marked with black pigment. Mesosoma: tergites I-VI blackish brown; tergite VII yellowish, with carinae brownish. Metasoma: segments I to IV yellowish; V reddish. Vesicle: same colour as segment V; extremity of aculeus darker than vesicle. Venter yellow. Chelicerae yellowish at their base; anterior region with variegated dark pigmentation; fingers dark reddish brown. Pedipalps: yellowish; fingers slightly reddish. Legs yellowish without any diffuse spots.

   Morphology. Carapace moderately to strongly granular; anterior margin with a median concavity. Anterior median superciliary and posterior median carinae moderately developed. All furrows moderately deep. Median ocular tubercle anterior to the center of the carapace. Three pairs of lateral eyes. Sternum triangular. Mesosoma: tergites strongly granular. Median carina strong on all tergites. Tergite VII pentacarinate. Venter: genital operculum wider than long. Pectines: pectinal teeth count 21/21; basal middle lamellae of the pectines slightly dilated. Sternites with a fine granulation and with elongate stigmata; VI without keels; VII with 4 moderately developed carinae. Metasoma: segments I-II with 10 carinae; segments III-IV with 8 carinae; segment V with 5 carinae. Intercarinal spaces weakly granular. Telson with vestigial granulation on ventral and lateral surfaces and with a long and strongly curved aculeus; subaculear tooth strong and spinoid, with two dorsal teeth. Cheliceral dentition characteristic of the family Buthidae; ventral teeth on movable finger reduced and almost fused (cf. Vachon, 1963); ventral aspect of both fingers and of manus densely covered with long setae. Pedipalps: femur pentacarinate; patella with 7 carinae; chela with 9 carinae; all carinae moderately to strongly developed; entire surface
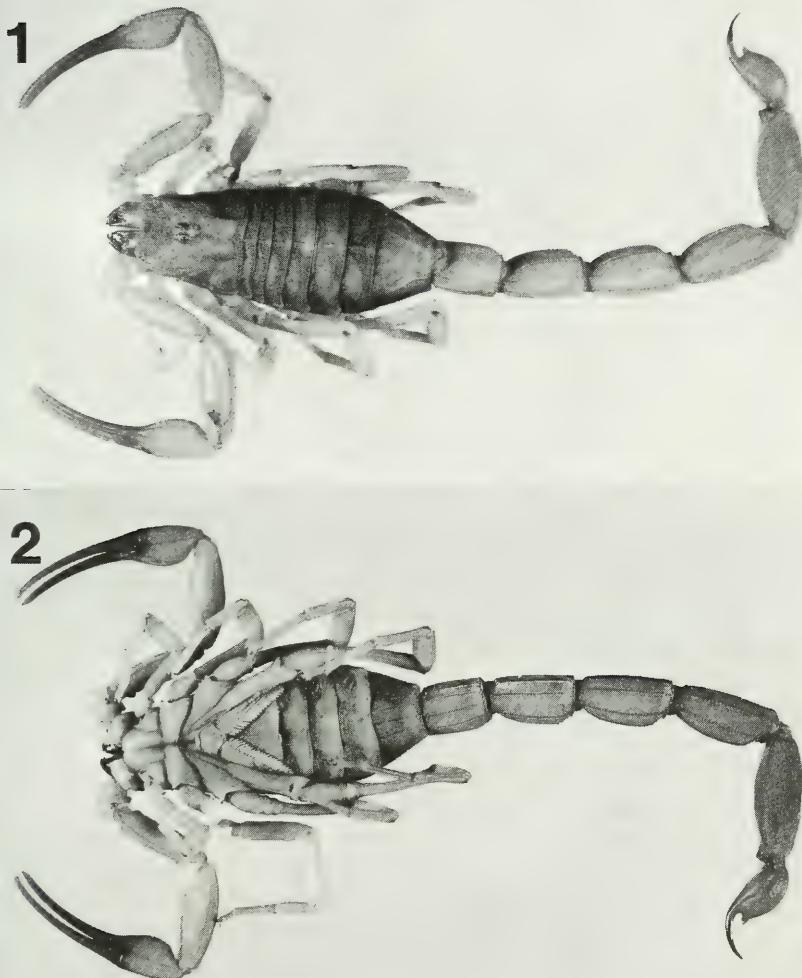
FIGS 1-2
Tityus adrianoi sp. n., female holotype. Dorsal and ventral aspects.

weakly granular. Fixed and movable fingers with 15/16 oblique rows of granules. Trichobothriotaxy; orthobothriotaxy A-α (Vachon, 1974, 1975). Legs: tarsus with numerous short fine setae ventrally.
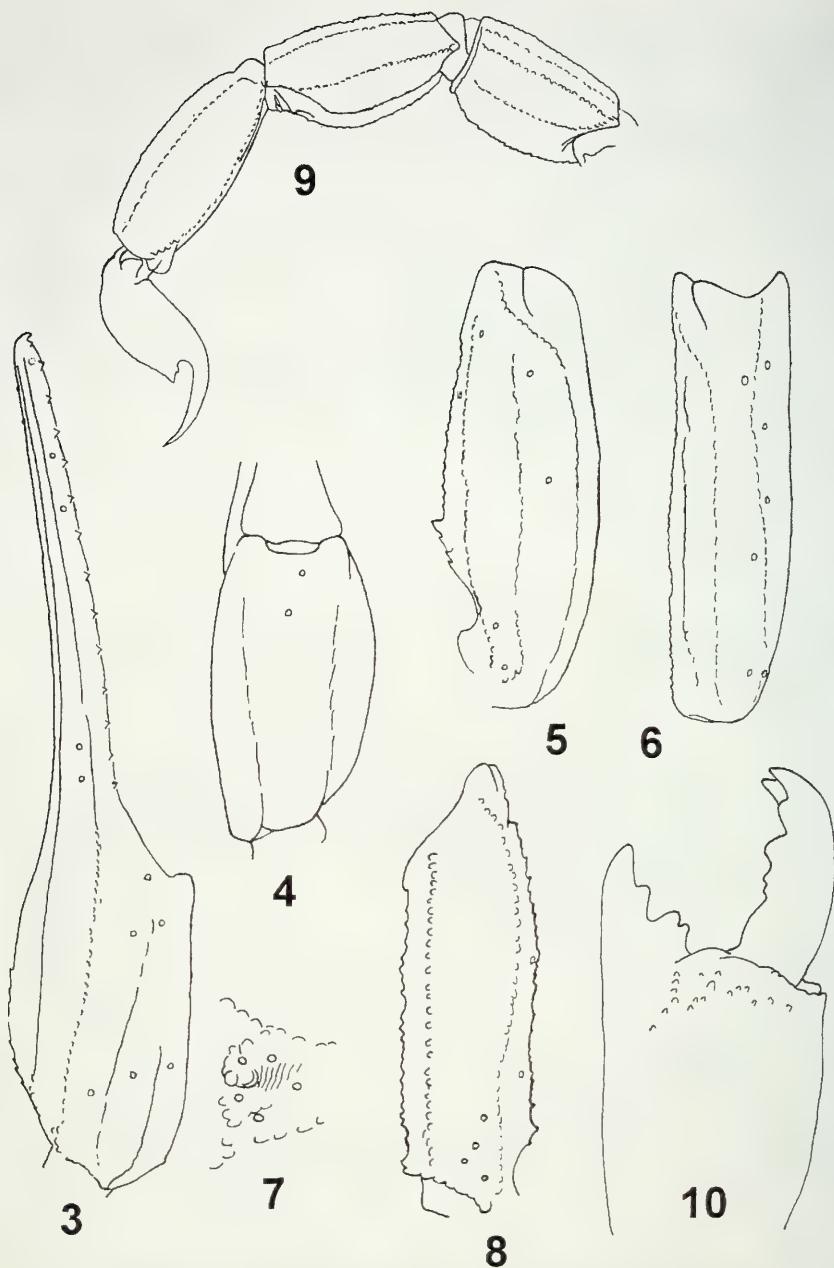
FIGS 3-10

Tityus adrianoi sp. n., female holotype. 3-8. Trichobothrial pattern of pedipalp. 3-4. Chela, dorso-external and ventral aspects. 5-6. Patella, dorsal and external aspects. 7-8. Femur, detail of the internal aspect and dorsal aspect. 9. Metasomal segment III-V and telson, lateral aspect. 10. Chelicera.

Measurements (in mm). Total length 55.1. Carapace: length 6.6; anterior width 4.4; posterior width 7.3. Metasoma, segment I: length 4.6; width 3.5. Metasoma, segment V: length 8.4; width 3.3; depth 3.2. Vesicle: width 2.4; depth 2.5. Pedipalp: Femur: length 6.6; width 1.9. Patella: length 7.5; width 2.5. Chela: length 13.1; width 2.6; depth 2.4. Movable finger: length 8.8.

RELATIONSHIPS

The new species *T. adrianoi* sp. n. belongs to the *Tityus bahiensis* species group. In its general coloration pattern the new species shows affinities with *Tityus blaseri* Mello-Leitão from Chapada dos Veadeiros in the State of Goiás. Both species are known from localities in between 1000 and 2000 m altitude and they are isolated by the Cerrado formations (sensu strictu) of Central Brazil.

The following characters are distinctive:

- The pigmentation of carapace and tergites is intensely dark, almost blackish in the new species, whereas in *T. blaseri* it is yellowish brown.

- In the new species fixed and movable pedipalp fingers show 15/16 rows of granules, whereas *T. blaseri* possesses 17/18 rows.

- The new species has 21 pectinal teeth, whereas *T. blaseri* posseses 23-25.

- The basal middle lamella of the pectines is weakly dilated in the new species, but not dilated in *T. blaseri*.

The new species can also be easily distinguished from *Tityus bahiensis* (Perty) and *Tityus serrulatus* Lutz & Mello, both found in the State of Minas Gerais. All three species show different patterns of pigmentation. Moreover, the new species lacks posterior spinoid granules on the dorsal carinae of the metasoma (see Lourenço, 2002 for details).

ENVIRONMENTAL CHARACTERISTICS OF THE TYPE LOCALITY

The Serra do Cipo is part of the Cerrado formations of Central Brazil. According to Eiten (1978, 1982), the type of cerrado found in Serra do Cipo is the one defined as Campo rupestre (or rocky field). These occur on certain highlands and on mountain tops and ridges at moderate altitudes, usually between 1000 and 1800 m. These campos have very high species endemicity. The soils are derived from special rock types, usually meta-quartzite (such as itacolomite), some also from fine grain ortho-quartzite, iron ore, etc. Soil derived from quartzites is a fine white or light gray sand, usually 10-30 cm thick, sometimes with humus. The bedrock usually outcrops in blocks so that the soil may vary in depth, humus content and drainage over distances of a few centimetres. The physiognomy of the vegetation may be low-tree and scrub woodland, open scrub, closed scrub, savanna or grassfield. According to Eiten (1978, 1982), the flora of the Campos rupestres can be divided into at least four categories. The Serra do Cipo region is characterised by species with a growth form typical of white sand campos in central Brazil and eastern Amazonia. This growth form is characterized by branches or their ends having closely-set, short, four-ranked leaves perpendicular to the stem, that is, they are squarrose or short-cruciate. Herbs, semi-shrubs and shrubs have this growth form; the larger woody plants have the same leaf-arrangement and a candelabra branching. Altogether, the plants are quite distinct from Cerrado plants.

KEY TO THE CERRADO SPECIES OF THE *TITYUS BAHIENSIS* GROUP

1   Metasomal segments III and IV with 1 to 5 granules modified as
        moderate or weak spines; coloration yellowish 2
(1)   Metasomal segments III and IV without granules modified as spines;
        coloration from yellow to blackish brown 3
2   One longitudinal dark stripe running over all tergites
        . . . . *T. stigmurus* (Thorell, 1876)
(2)   Confluent spots on tergites . . . . *T. serrulatus* Lutz & Mello, 1922
3   Coloration yellowish to reddish yellow with confluent pale brown or
        blackish spots 4
(3)   Coloration generally dark, brown to blackish brown or with 3 dark lon-
        gitudinal stripes on tergites 5
4   Coloration reddish yellow with confluent pale brown spots; distribution:
        State of Goiás . . . . *T. blaseri* Mello-Leitão, 1931
(4)   Coloration yellowish with confluent blackish spots; distribution: State of
        Minas Gerais . . . . *T. adrianoi* sp. n.
5   Coloration brown to blackish brown; tergites dark brown; spots present
        on pedipalps and legs 6
(5)   All tergites with 3 dark longitudinal stripes; spots present or absent on
        pedipalps and legs 7
6   Coloration blackish brown; spots on pedipalps blackish; distribution:
        States of Minas Gerais and São Paulo . . . . *T. bahiensis* (Perty, 1833)
(6)   Coloration brown; spots on pedipalps brown with small white circles;
        distribution: Federal District and the State of Goiás
        . . . . *T. jeanvellardi* Lourenço, 2001
7   Pedipalps and legs densely spotted; distribution: Federal District and the
        State of Goiás . . . . *T. fasciolatus* Pessôa, 1935
(7)   Pedipalps and legs with spots reduced or absent 8
8   Pedipalps and legs without spots; distribution: State of Mato Grosso do
        Sul . . . . *T. trivittatus* Kraepelin, 1898
(8)   Pedipalps with reduced spots; legs with diffuse spots; distribution:
        western part of the State of Goiás . . . . *T. charreyroni* Vellard, 1932

BIOGEOGRAPHY

        1. Most scorpion population of *Tityus* consist of monomorphic species. In the
region of Cerrados two closely related species, *Tityus fasciolatus* Pessôa and *Tityus
charreyroni* Vellard, occur in parapatry areas. A statistical study of traits, such as the
patterns of pigmentation, showed no variability within either population. Moreover,
pigmentation patterns within each population showed no variability during post-
embryonic development. Therefore these species are clearly distinct. These two
possible sibling species are both savannicolous, but they occupy different, quite spe-
cific microhabitats. *T. fasciolatus* is a termitophilous scorpion which lives exclusively
in termite mounds built by *Armitermes euamignathus* Silvestri, whereas *T. charreyroni*
lives under stones in a region west of that occupied by *T. fasciolatus* (Fig. 11). The
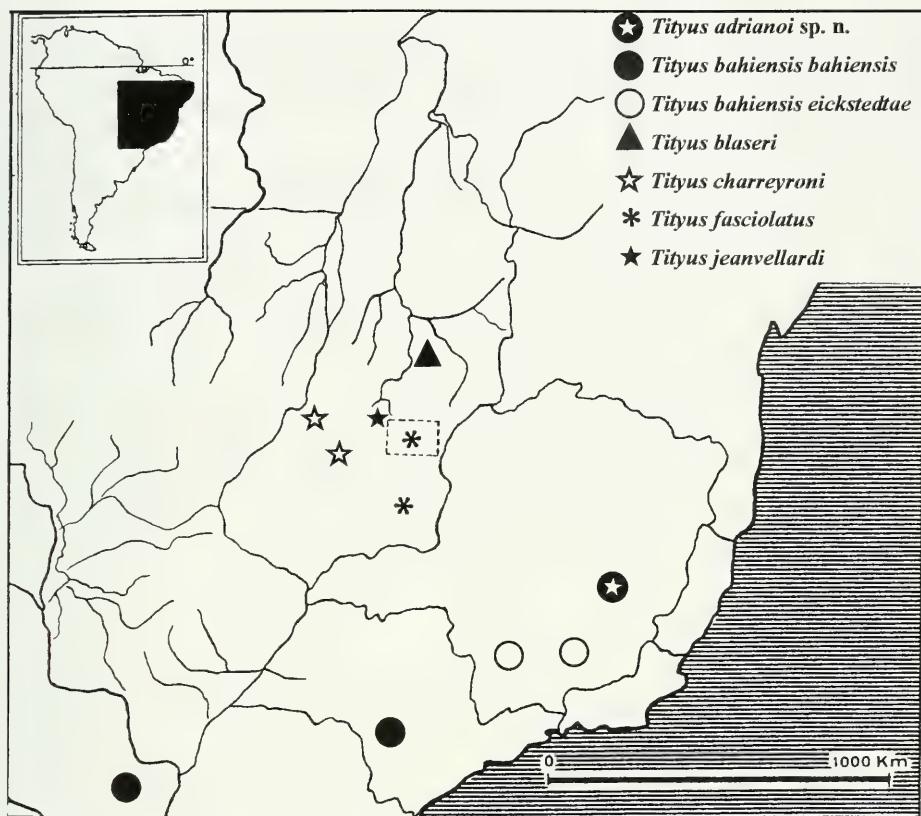
FIG. 11
Map showing the Central region of Brazil with the areas of distribution of some species discussed in this study.

occurrence of each species depends upon the presence of its specific microhabitat. *A. euamignathus* is associated with particular grasses, its staple food. With variation in the soil gradient, the vegetation also changes. Mounds of *A. euamignathus* are only present in association with a grass cover. When grass is no longer present, termite mounds and *T. fasciolatus* disappear. In areas where termite mounds are common, stones are rare, thus making the habitat unfavourable for *T. charreyroni*.

2. The study of *Tityus bahiensis* (Perty) (Lourenço, 1982), first suggested several morphological differences between northern and southern populations. This pattern was first interpreted as a multi-taxon situation by Lourenço (1982, 1994), with populations of different species and subspecies involved. This situation also illustrates the difficulties of clearly defining the biogeographic status of a given population. *T. bahiensis* is a very common species in the southeastern region of Brazil, and it represents an opportunistic species often living in disturbed habitats. Differences in the patterns of body pigmentation of individuals belonging to what appeared to be two

different allopatric populations first led to the recognition of two different species (Lourenço, 1982): *T. bahiensis* with a southern distribution and *T. eickstedtae* Lourenço, with a northern distribution. Moreover, additional data from the contact zone between the two populations indicated what could be interpreted as hybrid forms. More detailed studies, however, later suggested the existence of a single polytypic species (Lourenço, 1986) with two sub-species (and two sub-populations), one in the south (*T. bahiensis bahiensis*), the other in the north (*T. bahiensis eickstedtae*).

3. The biogeographic pattern presented by *Tityus adrianoi* sp. n. and by *Tityus blaseri* Mello-Leitão, suggests that these are allopatric species. The two species inhabitat similar landscape formations of the type Campo rupestre which, however, belong to different categories according to Eiten (1978, 1982 – see also paragraph "Environmental characteristics of the type locality"). Besides, these two areas are separated by almost 1000 km of typical Cerrado vegetation which acts as a barrier. This present pattern of geographical separation of the two species could suggest that in past geological times a contact zone existed between the two populations. The present pattern of distribution of the two species may be the result of the palaeoclimatological vicissitudes in tropical South America during the late Cenozoic and the Pleistocene (Lourenço, 1996).

ACKNOWLEDGEMENTS

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Amara pulpani Kult, 1949 – eine valide Art in den Ostalpen (Coleoptera: Carabidae)

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Amara pulpani Kult, 1949 – a valid species in the Eastern Alps (Coleoptera: Carabidae). - Based on extensive material from the Eastern Alps, the taxonomic position of *Amara pulpani* Kult, 1949, formerly often discussed and mostly considered synonymous with *Amara communis* (Panzer, 1797), is investigated. Based on morphological and ecological features the two taxa are considered to represent distinct species. The distribution of *A. pulpani*, recorded from Austria, Italy, Slovenia and Croatia for the first time, is shown. The following nomenclatural decisions are made; *Amara communis* var. *alpicola* Heer, 1837 = nomen dubium (contra Hieke, 1995); *Amara communis* var. *aenea* Heer, 1837 = *Amara nitida* Sturm, 1825, nov. syn. (contra Hieke, 1995).

Key-words: Coleoptera - Carabidae - *Amara* - taxonomy - ecology - Alps.

1. EINLEITUNG

Untersuchungen zur Systematik des *Amara communis*-Komplexes wurden bereits in größerer Zahl durchgeführt. Doch selbst ohne Berücksichtigung der zahlreich beschriebenen Synonyme (vgl. Hieke, 1995) zieht sich ein roter Faden interpretativer Widersprüchlichkeiten um die Stellung einiger Taxa durch die wissenschaftliche Literatur des 20. Jahrhunderts. Die heute auf breiter Basis anerkannte Differenzierung von *Amara communis* (Panzer, 1797) und *Amara convexior* Stephens, 1828 wurde noch vor wenigen Jahrzehnten in Frage gestellt; selbst der ausgezeichnete Carabiden-Systematiker Karl Lindroth synonymisierte beide Taxa (Lindroth, 1943), um einige Jahre später seinen Fehler einzugestehen (Lindroth, 1953).

Der Status der beiden weiteren Arten des *communis*-Komplexes ist jedoch nach wie vor umstritten. Hieke (1973, 1978) stellte *Amara pulpani* Kult, 1949 und *Amara makolskii* Roubal, 1923 als Synonyme zu *A. communis*, während Hejkal und Hůrka (*in* Hůrka, 1996), aber auch bereits Gersdorf & Kuntze (1957) sowie Burakowski (1967) Bestimmungsschlüssel für alle vier Taxa publizierten, ohne jedoch zufriedenstellende Abbildungen zur Differenzierung der Arten zu liefern. Meldungen von *A. pulpani* außerhalb Tschechiens und der Slowakei fanden bisher keinen Eingang in die faunistische Literatur (z. B. Bonadona, 1971; Kryzhanovskij *et al.*, 1995; Trautner *et al.*, 1997).

Kroatien:

Istrien, Učka, 26.5.1965, 2 ♀♀, leg. Freude, det. Paill. Istrien, Učka, 2.-8.6.1931, 1 ♀, leg. Stöcklein, det. Paill. Rijeka, Viševica (1200 m), 4.6.1939, 1 ♂, leg. Svirćev, det. Hejkal. Rijeka, Risnjak (1500 m), 8.7.1962, 1 ♀, leg. Malicky, det. Paill. Velebit, Senj, Krasanska duliba, 21.4.1979, 1 ♂, leg. Feller, det. Hejkal.

Italien:

Friaul Julisch Venetien, Cividale, Monte Matajur, 5.7.1922, 1 ♀, leg. Schatzmayr, det. Paill. Friaul Julisch Venetien, Pontebba, Monte Cavallo (1570 m), 7.1972, 1 ♂, leg. Schmidt, det. Hejkal. Friaul Julisch Venetien, Tolmezzo, Monte Festa, 4.9.1962, 1 ♀, leg. Springer, det. Paill. Friaul Julisch Venetien, Tolmezzo, Monte Festa, 23.6.1968, 1 ♂, leg. Springer, det. Hejkal. Friaul Julisch Venetien, Lago di Gavazzo (Monte Festa, 500-600 m), 16.6.1957, 1 ♂, leg. Springer, det. Paill. Friaul Julisch Venetien, Tarcento, Monte Bernadia, 11.5.1952, 1 ♀, leg. Busulini, det. Paill. Friaul Julisch Venetien, Lusevera, Musi (650 m), 17.6.1982, 1 ♀, leg. Delfabbro, det. Paill. Friaul Julisch Venetien, Maniago, Monte Raut (S-Seite, 1000 m), 7.1976, 1 ♀, leg. Schmidt, det. Paill. Friaul Julisch Venetien, Passo della Mauria, 20.6.1956, 1 ♂, leg. Fabris, det. Hejkal. Südtirol, Dolomiten, 6.1955, 1 ♀, leg. Vogt, det. Paill. Südtirol, Kastelruth, Seis am Schlern, 1.-13.6.1964, 1 ♂, leg. Abraham & Deeming, det. Hejkal. Südtirol, Bozen, 19.5.1890, 1 ♂, det. Paill. Südtirol, Bozen, Val d´arsa, 22.6.1923, 1 ♀, det. Paill. Südtirol, Grödnertal, St. Ulrich, 6.6.1962, 2 ♀♀, leg. Kirch, det. Paill. Südtirol, Valle del Fèrsina, Palai, 1 ♀, det. Paill. Lombardei, Gardasee, Tremosine, Vall di Bondo (600 m), 6.-7.6.1974, 1 ♀, leg. Schawaller, det. Paill.

Drei Populationen von *A. communis* lieferten Vergleichstiere; vom steirischen Fundort (CO2) wurden außerdem Tiere von *Amara lunicollis* Schiödte, 1837 zur Vermessung der Flügel herangezogen. Österreich, Kärnten, Ossiacher See, Bleistätter Moos (CO1, 46°41´N, 14°01´E, 510 m), 38 Exemplare. Österreich, Steiermark, W Liezen, Wörschacher Moos (CO2, 47°33´N, 14°11´E, 640 m), 32 Exemplare, 1 Larve. Deutschland, Baden-Württemberg, Stuttgart, Sindelfingen (CO3), 20 Exemplare.

2.2. MORPHOMETRIE UND GENITALMORPHOLOGIE

Die Körpermaße von *A. pulpani* wurden mit Hilfe eines Okularmikrometers ermittelt und mit jenen der nahe verwandten *A. communis* sowie im Falle der Flügelausbildung zusätzlich mit *A. lunicollis* verglichen. Die Länge der Elytren wurde von der Flügeldeckenbasallinie bis zur Flügeldeckenspitze gemessen, die häutigen Flügel wurden abpräpariert, aufgespannt und an ihrer breitesten Stelle sowie als leicht standardisierbares Maß ihrer Länge von der Adernaufzweigung zwischen den Hauptlängsadern Radius und Cubitus bis zur Flügelspitze vermessen (vgl. Abb. 4).

Die männlichen Genitalien wurden präpariert und in Kanadabalsam eingebettet. Die äußere Form des Aedeagus, die Innenstrukturen und die Ausbildung der linken Paramere wurden analysiert und den entsprechenden Ausbildungen bei *A. communis* gegenübergestellt. Im weiblichen Geschlecht erfolgte das Studium äußerer Merkmale am 8. und 9. Abdominalsegment.

Die Studien zur Genitalmorphologie, Flügelausbildung und zur Form des Halsschildvorderrandes basieren auf Tieren (5 ♂♂ und 5 ♀♀ je Population) aus den beiden aktuell in Österreich aufgefundenen Populationen (PU1, PU2). Die weiteren Vermessungen sowie die Registrierung von Färbungs- und Punktierungsmerkmalen wurden hingegen an allen aufgezählten Tieren durchgeführt.

3. ERGEBNISSE UND DISKUSSION

3.1. Morphologische Merkmale

3.1.1. *Körperlänge*

Die durchschnittliche Größe der männlichen *A. pulpani* lag bei 7.3 mm (6.3-8.1 mm), jene der weiblichen Tiere bei 7.7 mm (6.4-8.5 mm). Eine Häufigkeitsverteilung der Längenmaße geht aus Abb. 1. hervor. Von minimaler Körperlänge erwiesen sich ein Männchen mit 6.3 mm und ein Weibchen mit 6.4 mm, maximale Körperlänge erreichte ein 8.1 mm messendes Männchen bzw. ein Weibchen mit 8.5 mm. Während Kult (1949) bzw. Burakowski (1967) eine Körpergröße von 6.1-7.2 mm angeben, entspricht die von Hůrka (1996) ermittelte Spanne von 5.9-8.1 mm etwa den im Rahmen der vorliegenden Arbeit vermessenen Tieren (Abb. 1).

Deutliche Unterschiede konnten zwischen den Tieren der beiden näher untersuchten Populationen festgestellt werden. Bei durchschnittlich 7.4 mm gegenüber 7.1 mm im Falle der Männchen (t=2.7; p<0.05) und 8.1 mm gegenüber 7.2 mm bei den Weibchen (t=7.6; p<0.01) waren die Tiere der hochmontanen Population (PU1) signifikant größer als jene der subalpinen (PU2). Letztere Tiere waren damit so groß bzw. klein wie durchschnittliche Vertreter von *A. communis*.

3.1.2. *Körperform*

Der Körperumriss von *Amara* s. str. ist äußerst uniform. So unterscheiden sich *A. pulpani* und *A. communis* weder hinsichtlich des Quotienten aus Flügeldeckenlänge und -breite (1.37 bei *A. pulpani* bzw.1.35 bei *A. communis*), aus Flügeldeckenlänge und Halsschildlänge (2.52 bei *A. pulpani* bzw. 2.55 bei *A. communis*) sowie aus Flügeldeckenbreite und Halsschildbreite (1.08 bei beiden Arten). Signifikante Unterschiede sind jedoch im Breiten-Längen-Verhältnis des Halsschildes zu finden, welches im Falle von *A. pulpani* durchschnittlich 1.69 und bei *A. communis* 1.75 beträgt (t=6.23; p<0.01). Kult (1949) nennt für *A. pulpani* sogar einen Wert von 1.6. Differentialdiagnostisch bedeutend ist schließlich die Form des Halsschild-Vorderrandes. Die zur Differenzierung von *A. convexior* und *A. communis* relevante Abwinkelung der Vorderecken (Hieke, 1973) ist nämlich auch zwischen *A. communis* und *A. pulpani* signifikant unterschiedlich (t=20.32; p<0.01). Zwar liegt der Mittelwert für *A. communis* mit 34.9° aufgrund möglicherweise etwas anderer Meßmethode 5° über dem von Hieke (1973) angegebenen Wert, doch ist der Unterschied zu *A. pulpani* von etwa 10° bzw. 30% jedenfalls als konstant anzunehmen (Abb. 2).
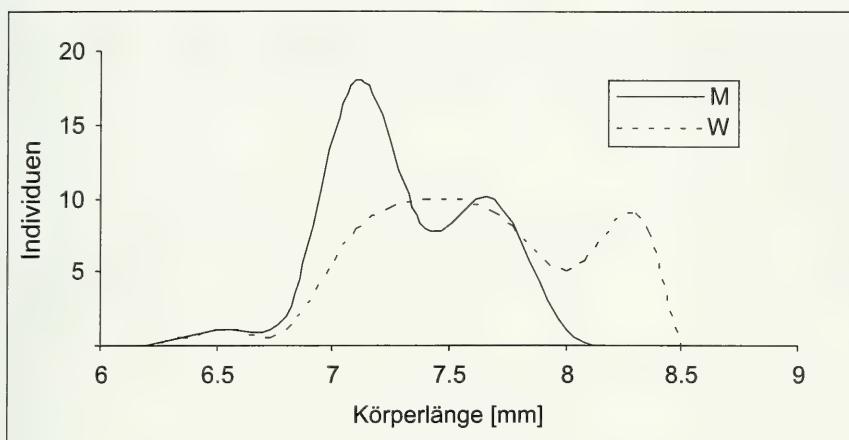
ABB. 1

Häufigkeitsverteilung der Körperlängen bei männlichen und weiblichen *Amara pulpani*.
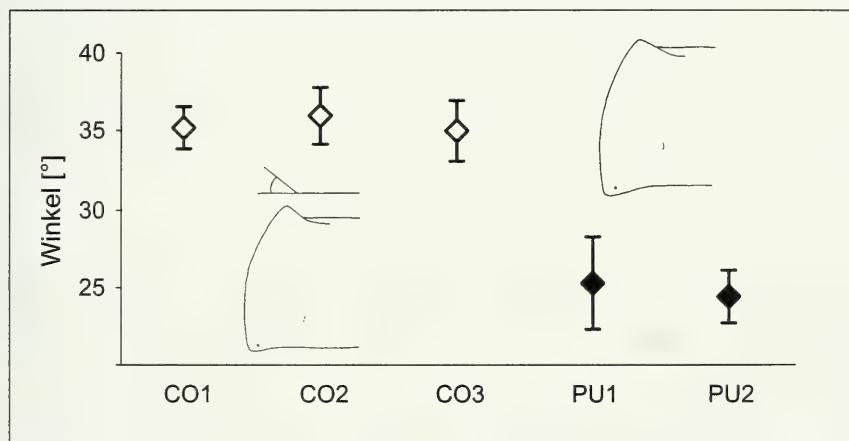
ABB. 2

Winkel der Halsschildvorderecken bei *Amara pulpani* (Populationen PU1, PU2) im Vergleich zu *A. communis* (CO1, CO2, CO3).

3.1.3. *Färbung*

Sowohl die Färbung der Körperoberfläche (2 der 86 normalerweise kupfer-färbigen *A. pulpani* zeichneten sich durch bläulichen Glanz aus) als auch die Aus-dehnung der Aufhellung der Antennenbasis bilden keine geeigneten Unterscheidungs-merkmale zwischen beiden Taxa. So ist das dritte Antennenglied bei *A. pulpani* zwar meist stärker verdunkelt als bei *A. communis*, doch treten bei der hinsichtlich dieses Merkmales sehr variablen *A. communis* auch Exemplare mit fast gänzlich verdun-keltem dritten Glied auf (vgl. Hieke, 1978, 1988). Auch der Färbung der Schienen kann

entgegen den Angaben von Kult (1949) und Burakowski (1967) kein differenzial-
diagnostischer Wert beigemessen werden, da kein Unterschied im Ausmaß der braun-
rötlichen Aufhellung im Vergleich zwischen *A. pulpani* und *A. communis* feststellbar
war.

3.1.4. *Flügelausbildung*

Die Länge der Hinterflügel von *A. pulpani* entspricht etwa der Länge der
Flügeldecken. Weder die Geschlechter noch die beiden untersuchten Populationen un-
terschieden sich in diesem Merkmal; die Relation zwischen Flügel- und Elytrenlänge
bei den Tieren aus der Trögerner Klamm betrug 0.98 und bei jenen von der Mussen 1.0.
Auch die relative Breite der Flügel war mit Werten von 1.16 (PU1) und 1.17 (PU2)
zwischen beiden Populationen identisch (Abb. 3).

Vergleiche mit *A. communis* offenbarten einen hochsignifikanten Unterschied in
der Flügelausbildung, der als differenzialdiagnostisches Merkmal zur Unterscheidung
beider Arten zumindest im mitteleuropäischen Raum anwendbar ist (Abb. 3, 4).
Demnach sind die Flügel von *A. communis* nicht nur in Relation zur Körpergröße deut-
lich länger (t=27.46; p<0.01) und breiter (t=24.82; p<0.01) als bei *A. pulpani*, sondern
auch aufgrund qualitativer Unterschiede (stärkere Sklerotisierung, größeres Analfeld)
offenbar besser für die Fortbewegung per Flug geeignet. Auch die von Drioli (1987)
vermessenen *A. communis* wiesen Hinterflügel von 1.5-1.6 facher Elytrenlänge auf.
Dennoch scheint *A. communis* trotz zahlreicher Nachweise (z. B. van Huizen, 1980)
nur selten tatsächlich flugfähig zu sein; diese Individuen besitzen neben einer gut aus-
gebildeten Flugmuskulatur, die sonst oft degeneriert ist (Tietze, 1963), auch längere
Flügel (Desender, 1989).

3.1.5. *Punktierung und Beborstung*

Der Halsschild von *A. pulpani* ist in den meisten Fällen relativ schwach punk-
tiert. Allerdings ist dieses tendenziöse Merkmal nicht geeignet, um eine sichere
Differenzierung von der zumeist deutlich kräftiger punktierten *A. communis* vor-
zunehmen; immerhin treten bei beiden Arten Individuen mit weitgehend fehlender bis
sehr kräftiger Punktierung auf (Abb. 2).

Die Ausbildung der Porenpunkte am Ende des 7. Flügeldeckenstreifens ist
hingegen von größerem Interesse. Die Anzahl dieser Punkte hat sich nämlich trotz
hoher Variabilität zu einem allgemein anerkannten Merkmal in der Differenzial-
diagnose innerhalb der Gattung *Amara* etabliert (z. B. Lindroth, 1943). Hůrka (1996)
führt das Auftreten von zwei bei *A. pulpani* gegenüber drei Punkten bei *A. communis*
als differentialdiagnostisches Merkmal zwischen den beiden Taxa an, während Hieke
(1973) den Wert dieses Merkmales anhand seiner Analysen bei mehreren Populationen
von *A. communis* und auch des Typenmaterials von *A. pulpani* kritisch hinterfragt. Die
eigenen Untersuchungen zeigten zwar den bedeutenden Wert dieses Merkmals,
konnten jedoch auch deren Variabilität festhalten. Demnach kann es bei beiden Arten
zu Veränderungen der Borstenzahlen kommen, die aber zumeist nur einseitig ausfallen.
A. pulpani scheint eine wesentlich höhere Konstanz dieses Merkmales zu besitzen,
nachdem lediglich eines der 86 untersuchten Individuen eine einseitig erhöhte
Porenzahl aufwies. Demgegenüber ist die Porenzahl bei *A. communis* als vergleichs-
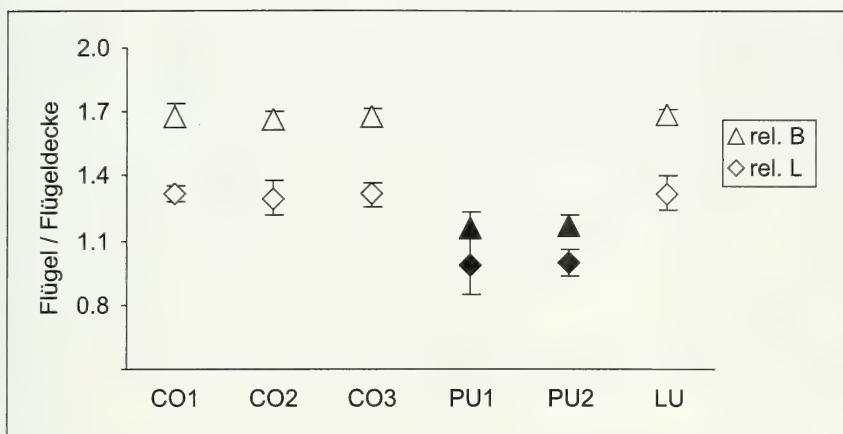
ABB. 3

Relative Flügellängen (rel. L) und -breiten (rel. B) bei *Amara pulpani* (Populationen PU1, PU2) und *A. communis* (CO1, CO2, CO3). Als Vergleich dient die häufig mit *A. communis* vergesellschaftete *A. lunicollis* (LU).
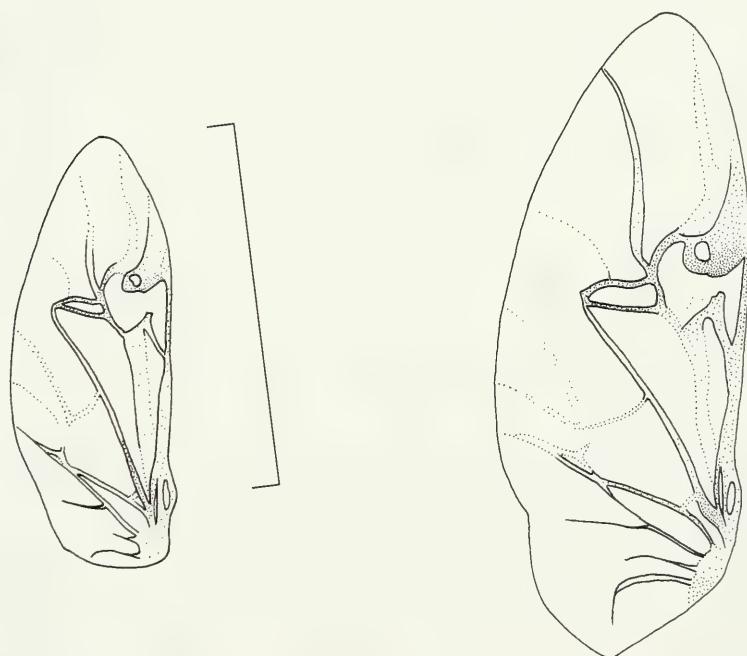
ABB. 4

Rechter Hinterflügel von *Amara pulpani* (a) und *A. communis* (b). Maßstab = 1 mm. Die Flügeldecken beider Tiere waren mit 4,0 mm von identischer Länge. Die Klammer verdeutlicht die Methode der Längenmessung.

weise variabel zu bezeichnen, zumal nicht weniger als 13% der 90 untersuchten
Individuen Abweichungen von der „Norm" zeigten. 10 Tiere hatten einseitig verän-
derte Borstenzahlen (2 Individuen mit 4 und 8 Individuen mit 2 Borsten) und bei zwei
Individuen waren an beiden Flügeldecken nur noch zwei Porenpunkte sichtbar, die bei
alleiniger Verwendung dieses Merkmales zu Verwechslungen mit A. pulpani führen
könnten. Berücksichtigt man jedoch die Tatsache, dass der Abstand zwischen dem
größten, am nächsten zur Flügeldeckenbasis gelegenenen Porenpunkt und dem mittel-
großen, zweiten Porenpunkt, bei A. pulpani wesentlich größer als bei A. communis ist
(Abb. 5), so läßt sich eine mögliche Reduktion des kleinsten, apikalen Porenpunktes
bei A. communis relativ leicht erahnen. Zu bedenken gilt zusätzlich, dass das Auffinden
des dritten Porenpunktes bei abgebrochener Borste nicht nur aufgrund seiner geringen
Größe sondern auch wegen der nicht selten veränderten Lage (vgl. Lindroth, 1943) am
apikalen Ende des ersten oder zweiten Flügeldeckenstreifens schwer fällt.

3.1.6. Genitalmorphologie

Innerhalb der Gattung Amara sind die Genitalien wenig differenziert. Dennoch
ermöglicht die hohe Konstanz der Merkmale deren Einsatz in der Differenzial-
diagnostik.

Der Aedeagus von A. pulpani ist geringfügig größer als jener von A. communis
und sein Apex verjüngt sich abweichend von der leicht konischen Divergenz bei A.
communis fast parallel (Abb. 6, 7). Dabei liegt das Apex-Längen-Breiten Verhältnis
beider Arten bei durchschnittlich 1.5 und entspricht damit den von Hůrka (1996)
angegebenen Maßen. Im Innensack fällt die Chitinisierung bei ausgehärteten Tieren
deutlich kräftiger als bei A. communis aus. Die linke Paramere ist etwas länger und die
Spitze als etwas kräftigerer Haken differenziert. Dieser liegt bei A. pulpani in der
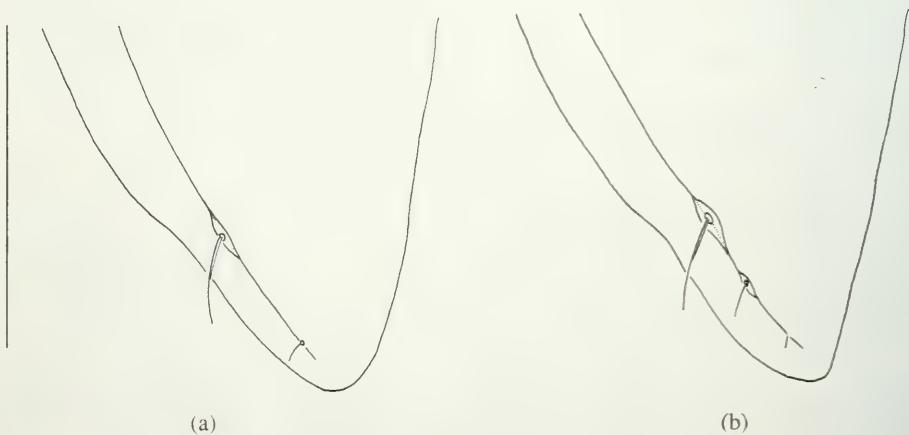
ABB. 5

Charakteristische Borstenstellung am Ende des 7. Flügeldeckenstreifens bei Amara pulpani (a)
und A. communis (b). Maßstab = 1 mm.

ABB. 6

Genitalmorphologie männlicher *Amara pulpani*. Aedeagus in Aufsicht, linke Paramere in Seitenlage, "Genitalring". Maßstäbe (Aedeagus groß, Paramere und Genitalring klein) = 1 mm.
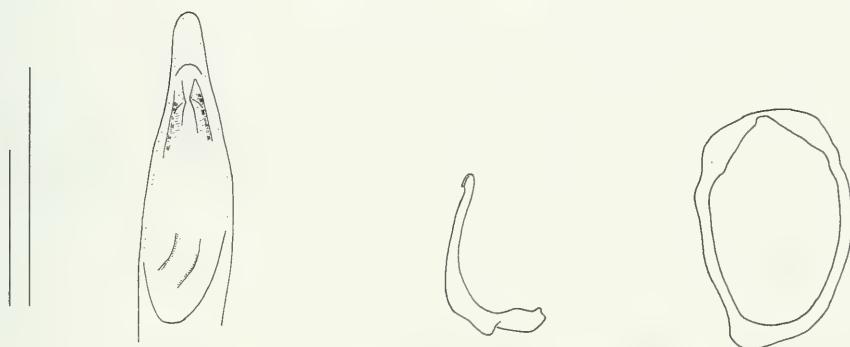
ABB. 7

Genitalmorphologie männlicher *Amara communis*. Aedeagus in Aufsicht, linke Paramere in Seitenlage, "Genitalring". Maßstäbe (Aedeagus groß, Paramere und Genitalring klein) = 1 mm.

Ebene der seitlich abgeflachten Paramere, während er bei *A. communis* deutlich zur Seite abgewinkelt ist und in der Abbildung daher vergleichsweise klein erscheint. Schließlich ist auch der als "Genitalring" differenzierte Teil des 9. Abdominalsegments im basalen Teil kräftiger ausgebildet und kann trotz relativ großer Variabilität als Differenzialmerkmal zwischen den beiden Arten gelten.

Das weibliche Genital liefert ebenfalls diffizile Unterschiede zwischen beiden Arten. Zwar ist die zur Differenzierung von *A. communis* und *A. convexior* heranziehbare Form der Gonocoxite (Hieke, 1976) zwischen *A. communis* und *A. pulpani* nur geringfügig abweichend. Auffallend ist jedoch die unterschiedliche Beborstung des apikalen Häutchens (Ventrit) am 9. Abdominalsegment: diese ist bei *A. pulpani* durch wesentlich kräftigere Borsten als bei *A. communis* gekennzeichnet. Hinzu kommt die unterschiedliche Form in der Sklerotisierung am 8. Abdominaltergit (Abb. 8, 9).
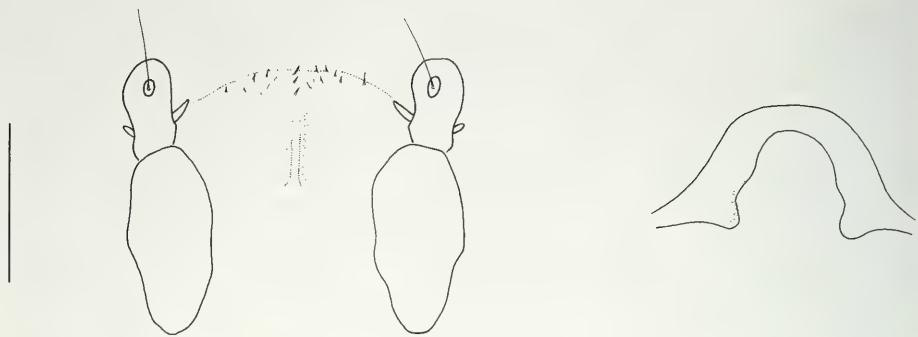
ABB. 8

Genitalmorphologie weiblicher *Amara pulpani*. Gonocoxite und Ventrit (8. Abdominalsegment), Sklerotisierung am 9. Abdominalsegment. Maßstab = 0,5 mm.
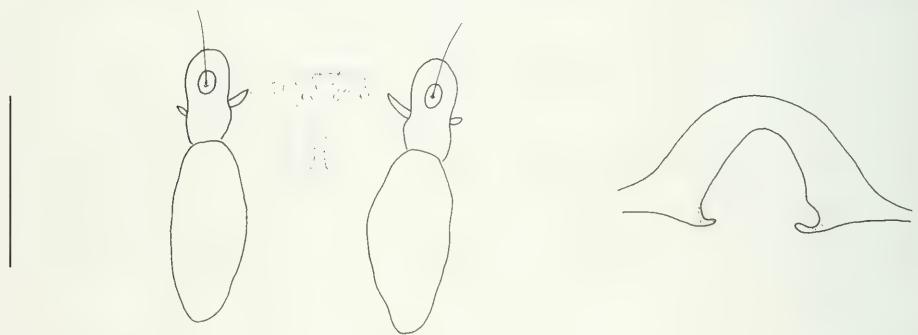
ABB. 9

Genitalmorphologie weiblicher *Amara communis*. Gonocoxite und Ventrit (8. Abdominal-segment), Sklerotisierung am 9. Abdominalsegment. Maßstab = 0,5 mm.

3.2. PHÄNOLOGIE

Die über einen Zeitraum von zwei Jahren mit Hilfe von Barberfallen unter-suchte Population CO1 in der Trögerner Klamm in 850 m Seehöhe bot die Gelegenheit, standardisierte Daten zur jahreszeitlichen Aktivität von *A. pulpani* zu gewinnen. In beiden Jahren trat *A. pulpani* bereits sehr früh im Jahr auf, erreichte im Mai bzw. Anfang Juni die maximale Laufaktivität und wurde danach kaum noch im imaginalen Stadium nachgewiesen. Der sommerlarvale Entwicklungsmodus konnte durch den Fund zweier Larven im Juli des zweiten Untersuchungsjahres sowie zweier immaturer, frisch geschlüpfter Käfer im darauffolgenden August bestätigt werden (Abb. 10). Korrespondierende Angaben zur Saisonalität von *A. pulpani* macht Kult (1949). Mit zunehmender Höhenlage dürften Erstauftreten und Populationsmaximum in den Hochsommer verschoben sein, wie die Erhebungen auf der Mussen (PU2) in 1900 m Seehöhe andeuten. Immature Käfer wurden hier erst im September gefangen.

3.3. LEBENSRAUM UND HÖHENVERBREITUNG

Die Standorte der beiden untersuchten Populationen von *A. pulpani* sind durch extrem trockene und auch thermisch günstige Verhältnisse gekennzeichnet. In der strukturreichen Trögerner Klamm bewohnt die Art ausschließlich steile, südexponierte Flanken. Die Standorte sind durch geringe Bodenbildung und mäßige Nährstoffversorgung gekennzeichnet. Die in der Baumschicht mehr oder weniger lückigen Schneeheide-Kiefernbestände (*Erico-Pinetum sylvestris*) sind durch mosaikartig eingestreute vegetationslose Offenstellen mit Dolomitgrus-Auflage (kleinflächige Schuttfluren) gekennzeichnet. Auch auf der Mussen bewohnt *A. pulpani* vegetationsarme Schuttfluren. Diese liegen hier inmitten ausgedehnter, traditionell bewirtschafteter skelettbodenreicher Kalkmagerrasen (*Seslerio-Caricetum sempervirentis*) im Bereich besonders steiler oder anthropogen beeinflusster (Mahd, Weganschnitte) Stellen. Neben der Schneeheide (*Erica carnea*) erreichen Alpen-Steinquendel (*Acinos alpinus*), Hufeisenklee (*Hippocrepis comosa*), Wilde Nelke (*Dianthus sylvestris*), Alpen-Labkraut (*Galium anisophyllum*), Kriech-Quendel (*Thymus praecox*), Alpenhelm (*Bartsia alpina*) und Herzblatt-Kugelblume (*Globularia cordifolia*) höhere Deckung (Wieser & Komposch, 2002).

Die Lebensräume der beiden österreichischen Populationen korrespondieren mit den Angaben aus Tschechien und der Slowakei, wo *A. pulpani* in trockenen Biotopen wie Schutthalden, Heiden (oftmals *Calluna*), Waldsteppen und Waldrändern auftritt (Kult, 1949; Hůrka, 1996). Indifferenz besteht offenbar hinsichtlich der Deckung der Baumschicht. In den genannten Ländern gilt die Art als Verteter der Gebirgsregion, was ebenfalls gut zu den aktuellen Funden aus den Alpen passt. Die Population von der Mussen mit einzelnen Tieren aus 1900 m dürfte sogar den bisher höchsten Fund von *A. pulpani* darstellen.

Die stenöke *A. pulpani* unterscheidet sich im ökologischen Verhalten grundlegend von *A. communis*. Letztere Art hat ein deutlich breiteres Lebensraumspektrum und kommt überwiegend auf frischen bis mäßig feuchten Wiesen und Hochstauden vor. Nur selten werden leicht bewaldete Standorte und ausgesprochen trockene Biotope besiedelt (z. B. Dülge *et al.*, 1994; Marggi, 1992; Tietze, 1973; Turin, 2000; Lindroth, 1986; Luff *et al.*, 1992). Außerdem vikariiert *A. communis* offenbar auch hinsichtlich der bewohnten Höhenstufe mit *A. pulpani*. So kennt Marggi (1992) in der Schweiz kaum *A. communis*-Populationen oberhalb von 600 m und in Südosteuropa werden Höhengrenzen von 1400 m genannt (Hieke & Wrase, 1988; Guéorguiev & Guéorguiev, 1995). Allerdings sind diese Angaben zu hinterfragen, zumal es sich bei den Meldungen aus höheren Lagen durchaus um *A. pulpani* handeln könnte. Konkrete Vermutung dafür besteht jedenfalls für Tiere, die vom Glocknermassiv in den Hohen Tauern aus über 1600 m Höhe gemeldet wurden (Franz, 1943; Jung, 1981) und ebenso für Individuen aus Felsenheiden und subalpinen Rasen in den Südalpen (Brandmayr & Zetto Brandmayr, 1988).
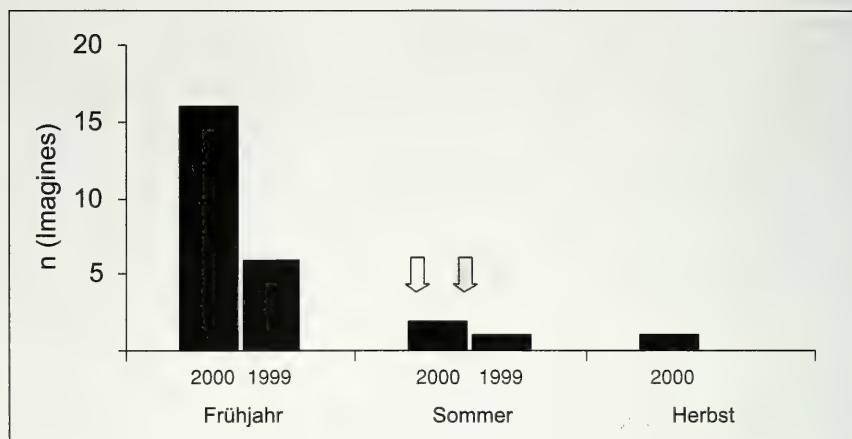
ABB. 10

Jahrezeitliches Auftreten (1999 und 2000) von *Amara pulpani* in der Trögerner Klamm. Imagines (schwarze Balken), Larven (weißer Pfeil) und immature Käfer (grauer Pfeil).

3.4. BEGLEITFAUNA

An beiden österreichischen Standorten zählte *A. pulpani* (zumindest über den jeweils bearbeiteten Zeitraum) zu den häufigsten Laufkäferarten. Im Schneeheide-Kiefernwald in der Trögerner Klamm stellte *A. pulpani* sogar 50% der gefangenen Individuen der insgesamt aus 8 Arten bestehenden arten- und individuenarmen Laufkäferzönose. Als weitere autochthone Arten traten unter anderem *Carabus cancellatus dahli* Heer, 1841, *Carabus arcensis* Herbst, 1784, *Molops ovipennis* Chaudoir, 1842 und *Abax ovalis* (Duftschmid, 1812) auf.

In der Schuttflur auf der Mussen erreichte *A. pulpani* 40% der Aktivitätsdominanz und wurde nur von *Harpalus solitaris* Dejean, 1829 als häufigste Art der Zönose übertroffen. Auch hier wird die Gemeinschaft aus wenigen weiteren subrezenten Vertretern wie *Carabus germarii* Sturm, 1815 und *Pterostichus jurinei* (Panzer, 1803) gebildet.

An keinem der beiden Standorte konnte eine Vergesellschaftung von *A. pulpani* mit *A. communis*, noch mit einer anderen *Amara*-Art, sieht man von einem Einzeltier von *A. convexior* am Standort PU1 ab, festgestellt werden.

3.5. VERBREITUNG

Im Nordosten Mitteleuropas ist die Verbreitung von *A. pulpani* aufgrund der in Tschechien und der Slowakei durchgehenden Anerkennung als eigenständiges Taxon relativ gut bekannt. Hier ist die Art zwar relativ selten aber weit verbreitet (Kult, 1949; Hůrka, 1996). Darüberhinaus waren bisher nur vereinzelte gesicherte Nachweise bekannt. So erwähnt Kult (1949) in seiner Beschreibung weiteres Material aus Deutschland, Frankreich (ohne genaue Lokalisierung) und der Ukraine (Karpaten, Galicia: Lwów). Horion (1951) gab *A. pulpani* auch für Polen an, offenbar in fälsch-

licher Zuordnung der Meldung aus "Galicia" (vgl. Burakowski *et al.*, 1974), und aus Österreich, ohne jedoch auf Fundorte oder Belegtiere einzugehen.

Anhand des vorliegenden Materials wird *A. pulpani* nun erstmals für Österreich, Slowenien, Kroatien und Italien sowie nach Kult (1949) und Gersdorf & Kuntze (1957) bzw. Horion (1960) abermals für Deutschland gemeldet (Abb. 11). Eine weitere Verbreitung der mittel-südosteuropäischen Art im nördlichen Alpenvorland bis Mitteldeutschland (mündl. Mitteilung H. Terlutter) und in den Gebirgszügen des Balkans ist wahrscheinlich.
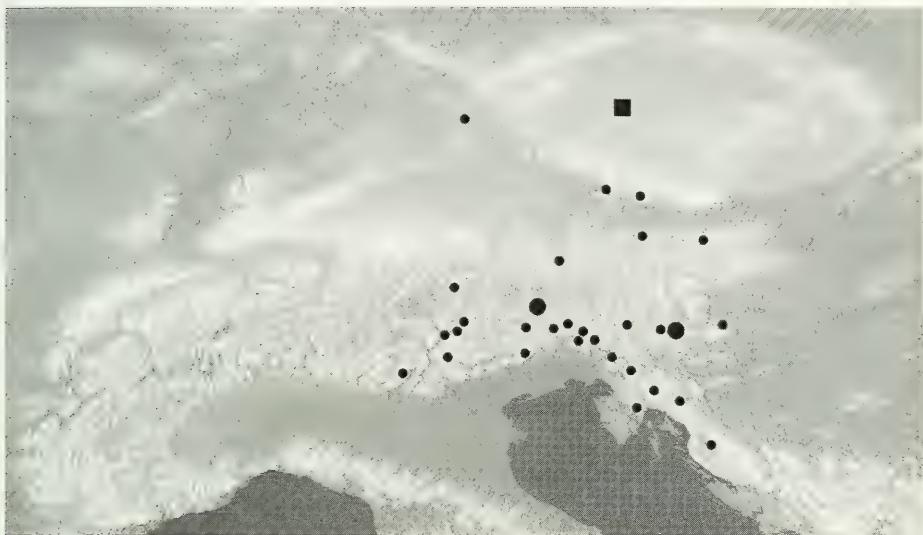
ABB. 11

Verbreitung von *Amara pulpani*. Mit Ausnahme der zwar in der Literatur genannten, aber nicht exakt lokalisierbaren Funde sind alle bekannten Vorkommen verzeichnet; die Häufung an Nachweisen in Tschechien und der Slowakei ist durch ein helles Oval angedeutet. Der Typus-Fundort ist durch ein schwarzes Quadrat und die aktuell untersuchten Populationen in Österreich (PU1 und PU2, siehe Text) sind durch große Kreise symbolisiert.

3.6. DETERMINATION

Die sichere Bestimmung von Einzeltieren von *A. pulpani* kann Schwierigkeiten bereiten. Jedenfalls müssen mehrere Merkmale, nämlich zumindest Anzahl und Lage der Porenpunkte am terminalen Ende des 7. Flügeldeckenstreifens, der Winkel des Halsschildvorderrandes und die relativen Flügelmaße berücksichtigt werden. Ein dichotomer Bestimmungsschlüssel soll zum gegenwärtigen Zeitpunkt noch nicht dargestellt werden, zumal auch im zentralen mitteleuropäischen Raum mit dem Vorkommen einer weiteren sehr ähnlichen Art, *A. makolskii*, zu rechnen ist.

3.7. NOMENKLATORISCHE ANMERKUNGEN

Untersuchtes Material: *Amara communis* var. *alpicola* Heer, 1837 (ETH Zürich): etikettiert mit "Typus ?", "f" (Fundortkürzel "f" = Kanton Glarus laut Catalog

der Schweizer Sammlung Coleoptera, schriftl. Mitt. Schmid, ETH Zürich), "*Amara* (*Amara*) *curta* Dej. det. F. Hieke 1984". *Amara communis* var. *aenea* Heer, 1837 (ETH Zürich): etikettiert mit "Syntypus", "e" (Fundortkürzel "e" = Rheinwald laut Catalog der Schweizer Sammlung Coleoptera, schriftl. Mitt. Schmid, ETH Zürich), "*Amara* (*Amara*) *nitida* Sturm det. F. Hieke 1984". *Amara brunnicornis* Heer, 1837 (ETH Zürich): Holotypus. *Amara aubryi* Schuler, 1964 (Musée Zoologique de Strasbourg): Holotypus und weitere von Schuler als *A. aubryi* determinierte Tiere.

Hieke (1995) führt in seinem Namensverzeichnis der Gattung *Amara* zahlreiche Synomyme von *A. communis* an. Die Gültigkeit des derzeit verwendeten Namens von *A. pulpani* musste daher hinterfragt werden. Mit *Amara communis* var. *alpicola* Heer, 1837 wurde ein aufgrund der Fundumstände in subalpiner Lage am ehesten in Frage kommendes Taxon aus der Liste von Hieke untersucht. Allerdings fällt die Interpretation des einzig vorhandenen Tieres schwer. So enthält der mit "Typ ?" versehene Beleg ein sich auf den Kanton Glarus beziehendes Fundortkürzel, während Heer (1837) in der Originalbeschreibung Rheinwald und später präziser (Heer, 1841) Nufenen im Rheinwald (Anmerkung: im Kanton Graubünden auf etwa 1600 m Höhe gelegen) als Lokalität nennt. Nach Vorlage dieses möglicherweise nicht richtig zugeordneten Typus stellte sich außerdem heraus, dass das Tier von Hieke als *Amara curta* (richtig) determiniert und bezettelt worden war, ein Umstand der jedoch keine Fortführung im zitierten Verzeichnis fand, wo *Amara communis* var. *alpicola* Heer, 1837 als Synonym von *A. communis* geführt wird. *Amara communis* var. *alpicola* Heer, 1837 kann nach derzeitigigem Wissensstand daher weder *A. communis* noch *A. curta* zugeordnet werden, sondern muss als nomen dubium abgelegt werden. *Amara communis* var. *aenea* Heer, 1837 ist gleichfalls kein Synonym von *A. communis*, wie fälschlicherweise trotz anderslautender Revision des Lectotypus durch Hieke im Namensverzeichnis geführt, sondern dem Taxon *Amara nitida* zuzuordnen. Überdies sind beide Namen jüngere Homonyme (von *Amara alpicola* Dejean, 1828 bzw. *Amara aenea* (De Geer, 1774) und daher nicht verfügbar. *A. brunnicornis* Heer, 1837 wurde aufgrund des "verdächtigen" Namens ebenfalls untersucht, ist jedoch ein Synonym von *Amara curta*, wie von Hieke (1995) bereits dargestellt. Die ebenfalls aus dem Rheinwald beschriebene *Amara communis* var. *atrata* Heer, 1837 fehlt in der Typensammlung Heer an der ETH Zürich (schriftl. Mitt. Schindler) und konnte daher leider nicht untersucht werden.

Weitere Namen wurden auf Basis ausreichend begründeter Synonymisierungen mit *A. communis* (*A. aemilina* Fiori, 1903 und *A. manevali* Jeannel, 1942 nach Hieke, 1973; *A. nigrita* Chaudoir, 1844 und *A. viatica* Motschulsky, 1845 nach Hieke, 1975; *Carabus vagabundus* Duftschmid, 1812 und *A. atrocoerulea* Sturm, 1825 nach Schaum, 1846) oder aufgrund tiergeografischer Überlegungen (*A. latescens* Stephens, 1828, *A. obtusa* Stephens, 1828, *A. plebeja* Stephens, 1828, *A. dalei* Rylands, 1841 jeweils aus planaren Lagen in Großbritannien beschrieben; *A. impressa* Motschulsky, 1848 aus Kasachstan beschrieben) ausgeschieden.

Die Synonymisierung von *A. aubryi* Schuler, 1964 mit *A. communis* (Hieke, 1988) konnte nach Vorlage des Holotypus und weiteren Materials bestätigt werden, nachdem auf Basis der von Hieke ausführlich beschriebenen Merkmale eine Synonymie mit *A. pulpani* nicht ausgeschlossen werden konnte.

4. DANK

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